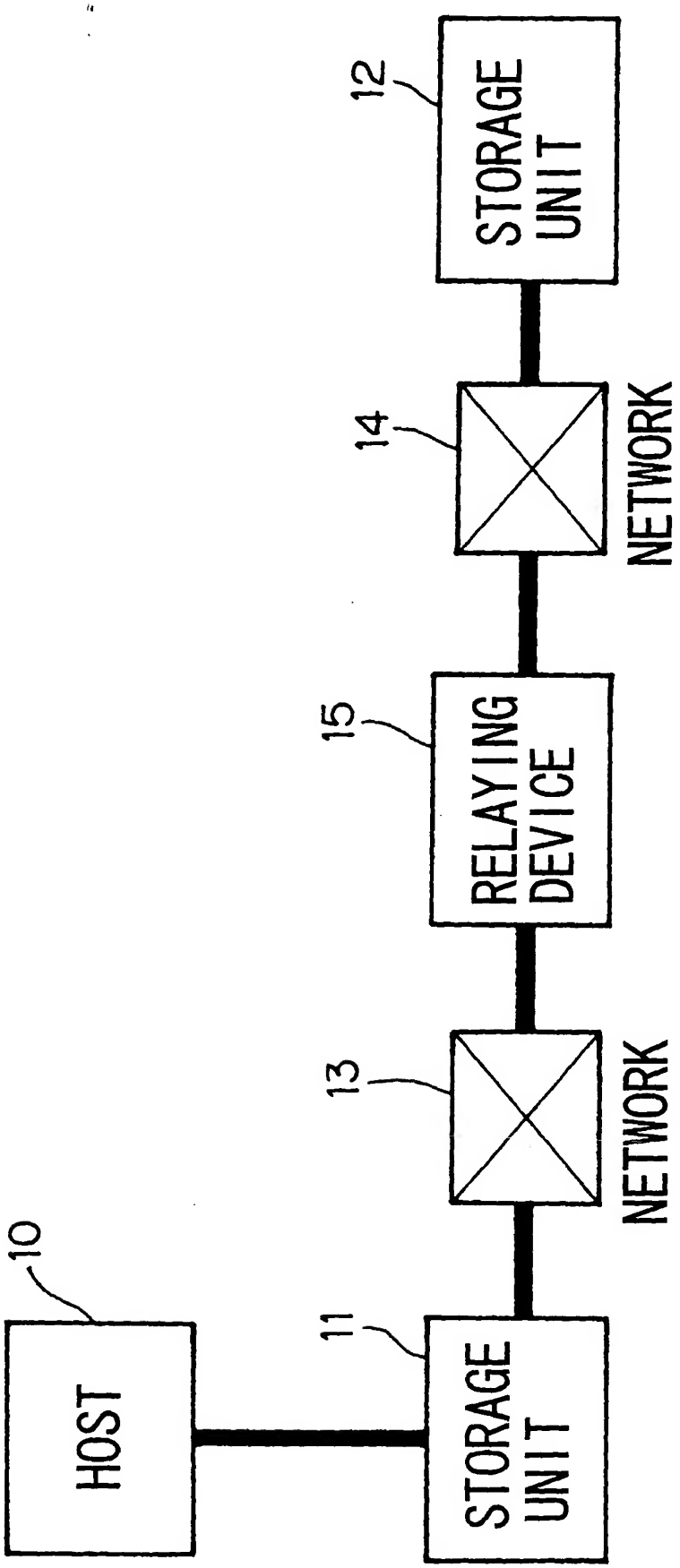

HOST
10
STORAGE UNIT
11
NETWORK
13
RELAYING DEVICE
15
NETWORK
14
STORAGE UNIT
12

FIG. 1

FIG . 2

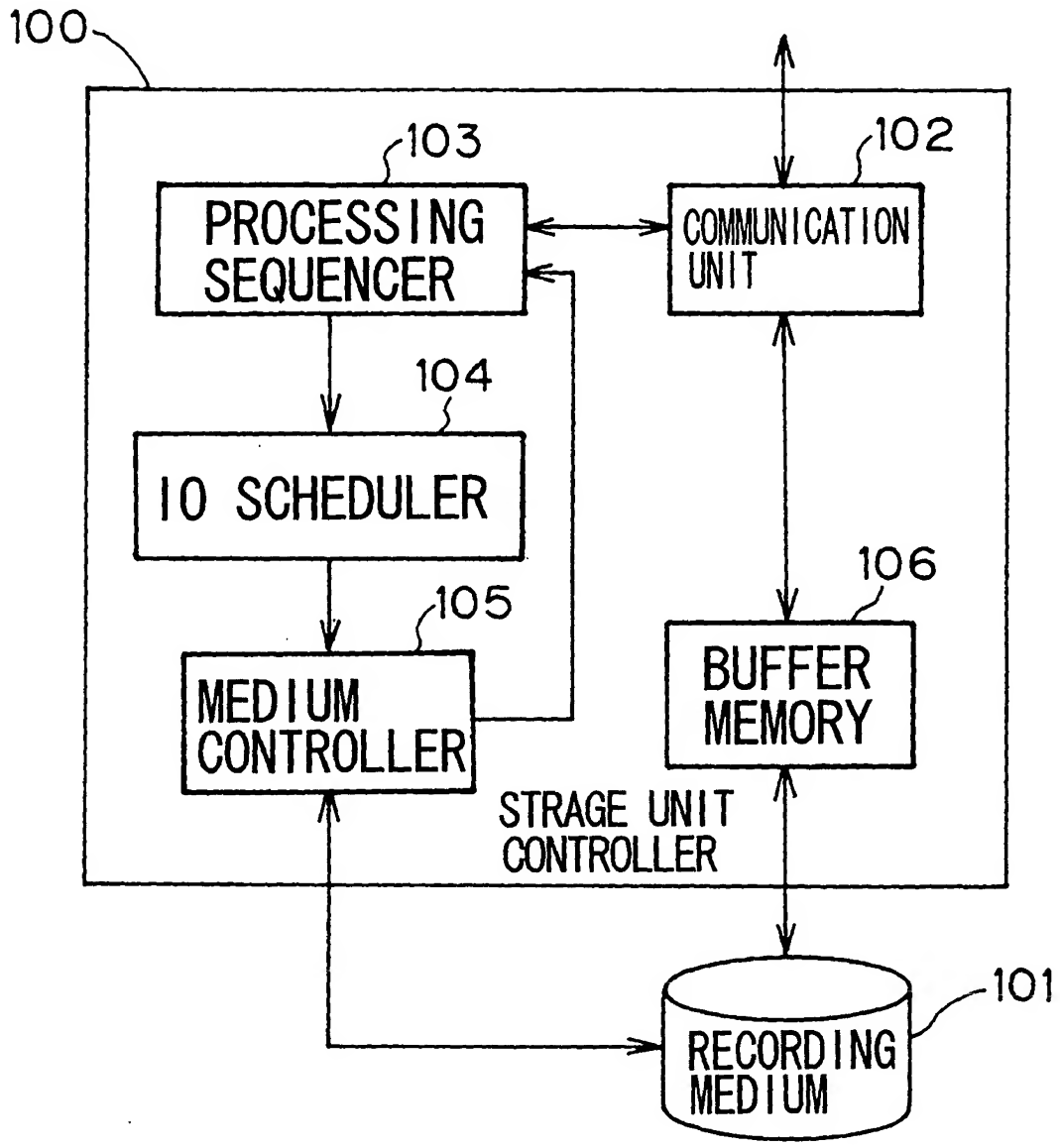

100
103
PROCESSING SEQUENCER
102
COMMUNICATION UNIT
104
IO SCHEDULER
106
105
MEDIUM CONTROLLER
BUFFER MEMORY
STRAGE UNIT CONTROLLER
101
RECORDING MEDIUM

FIG . 3

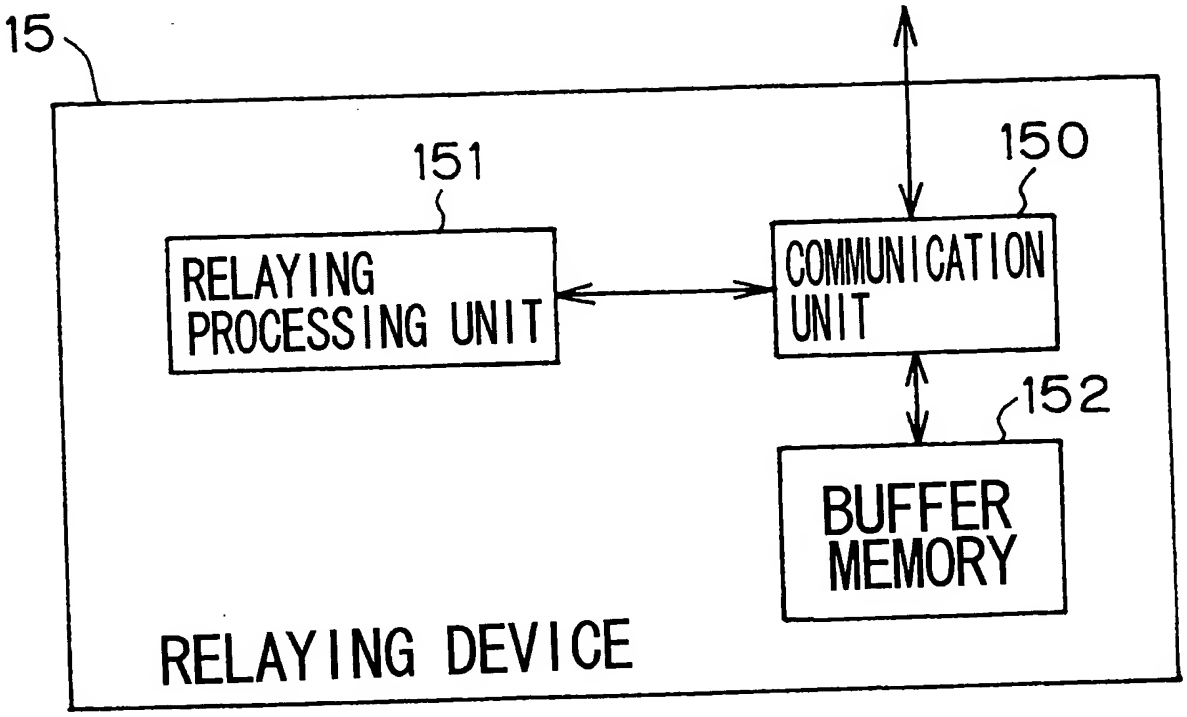

15
151
150
RELAYING PROCESSING UNIT
COMMUNICATION UNIT
152
BUFFER MEMORY
RELAYING DEVICE

FIG . 4

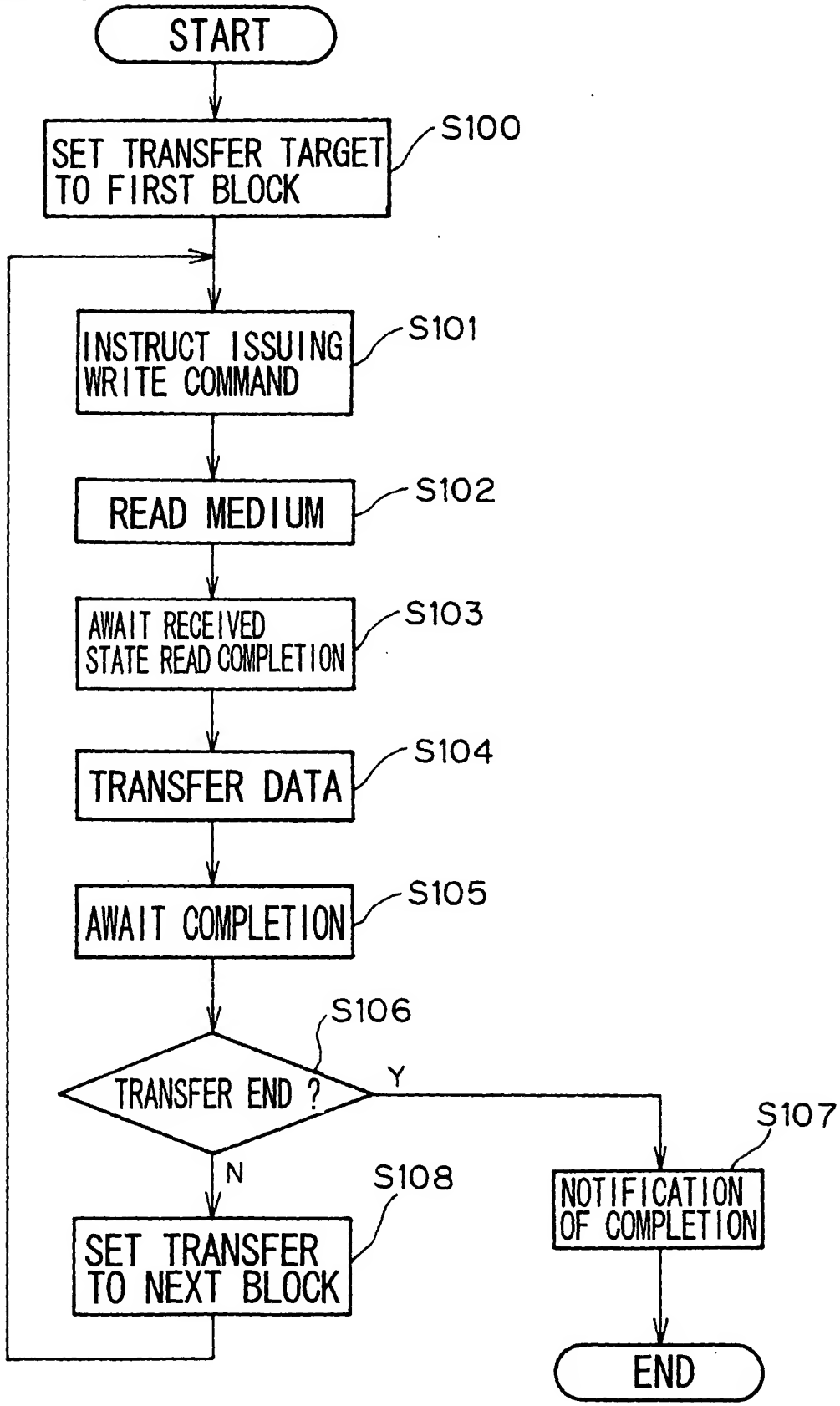

START
SET TRANSFER TARGET TO FIRST BLOCK
S100
INSTRUCT ISSUING WRITE COMMAND
S101
READ MEDIUM
S102
AWAIT RECEIVED STATE READ COMPLETION
S103
TRANSFER DATA
S104
AWAIT COMPLETION
S105
S106
TRANSFER END ?
Y
N
S107
NOTIFICATION OF COMPLETION
S108
SET TRANSFER TO NEXT BLOCK
END

FIG . 5

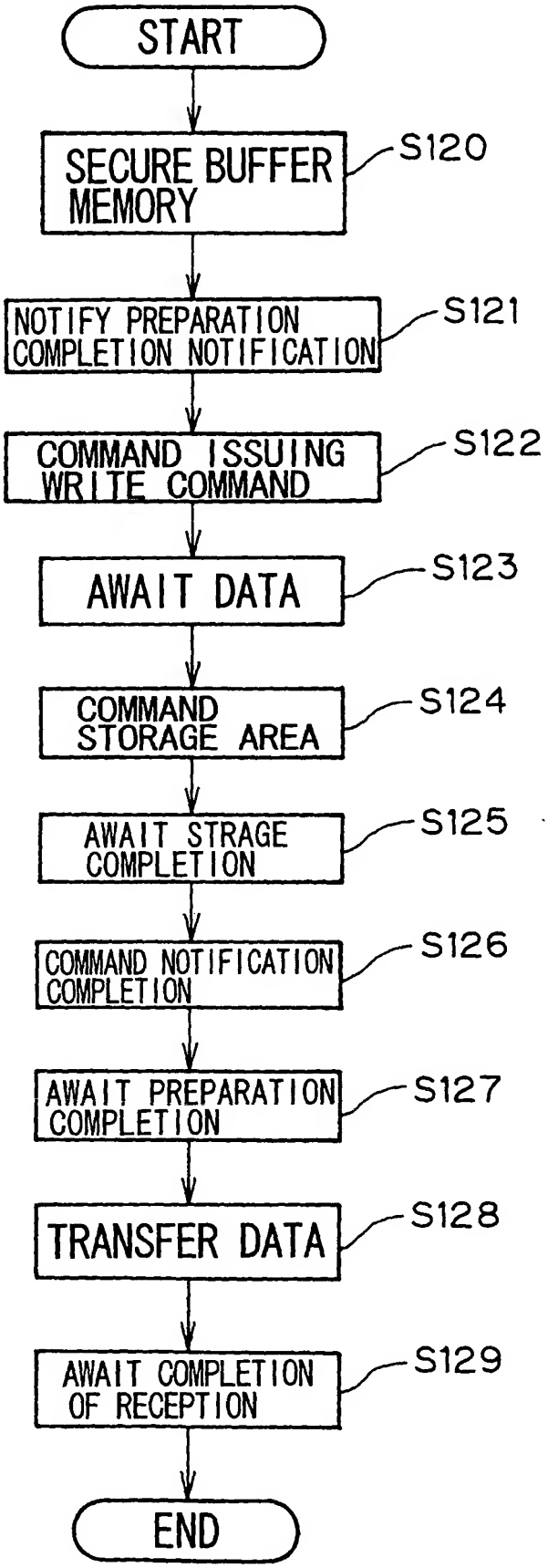

START
SECURE BUFFER MEMORY
S120
NOTIFY PREPARATION COMPLETION NOTIFICATION
S121
COMMAND ISSUING WRITE COMMAND
S122
AWAIT DATA
S123
COMMAND STORAGE AREA
S124
AWAIT STRAGE COMPLETION
S125
COMMAND NOTIFICATION COMPLETION
S126
AWAIT PREPARATION COMPLETION
S127
TRANSFER DATA
S128
AWAIT COMPLETION OF RECEPTION
S129
END

FIG . 6

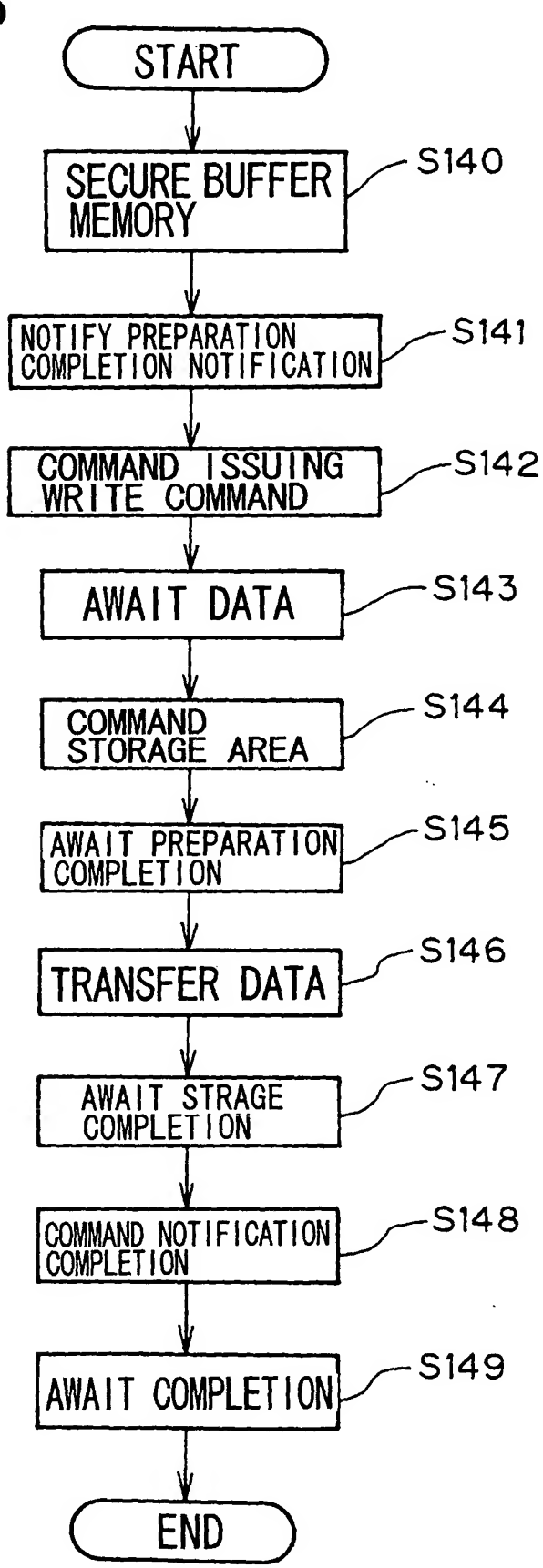
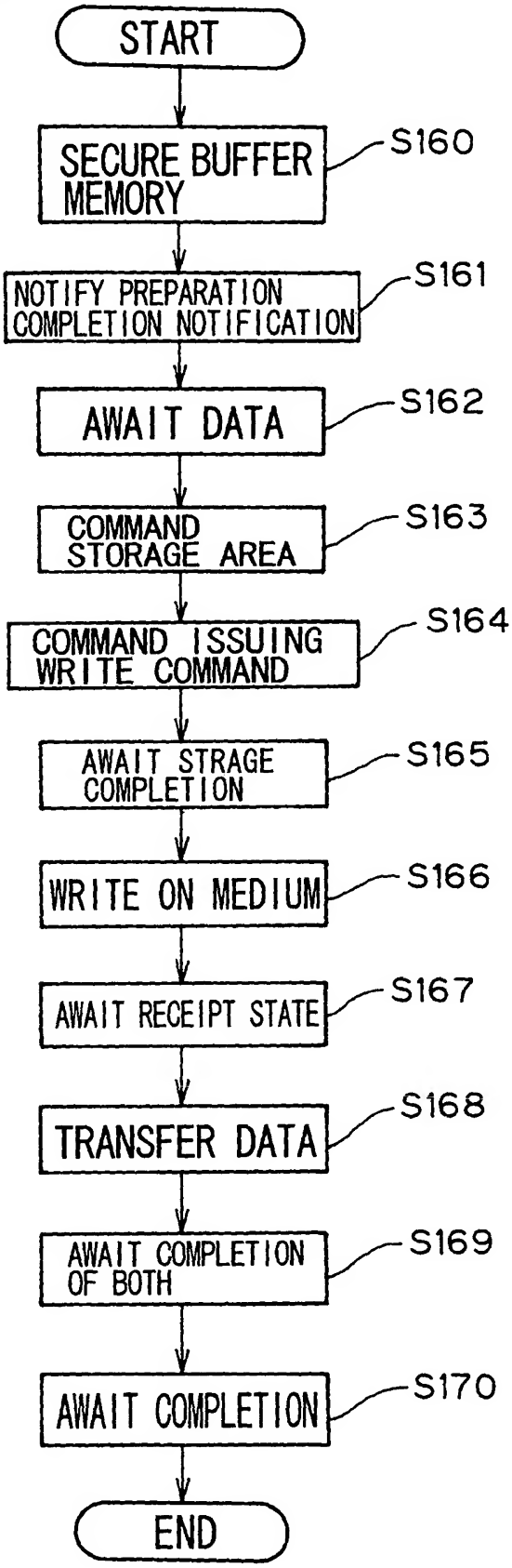

START
SECURE BUFFER MEMORY
S140
NOTIFY PREPARATION COMPLETION NOTIFICATION
S141
COMMAND ISSUING WRITE COMMAND
S142
AWAIT DATA
S143
COMMAND STORAGE AREA
S144
AWAIT PREPARATION COMPLETION
S145
TRANSFER DATA
S146
AWAIT STRAGE COMPLETION
S147
COMMAND NOTIFICATION COMPLETION
S148
AWAIT COMPLETION
S149
END

FIG . 7


START
SECURE BUFFER MEMORY
S160
NOTIFY PREPARATION COMPLETION NOTIFICATION
S161
AWAIT DATA
S162
COMMAND STORAGE AREA
S163
COMMAND ISSUING WRITE COMMAND
S164
AWAIT STRAGE COMPLETION
S165
WRITE ON MEDIUM
S166
AWAIT RECEIPT STATE
S167
TRANSFER DATA
S168
AWAIT COMPLETION OF BOTH
S169
AWAIT COMPLETION
S170
END

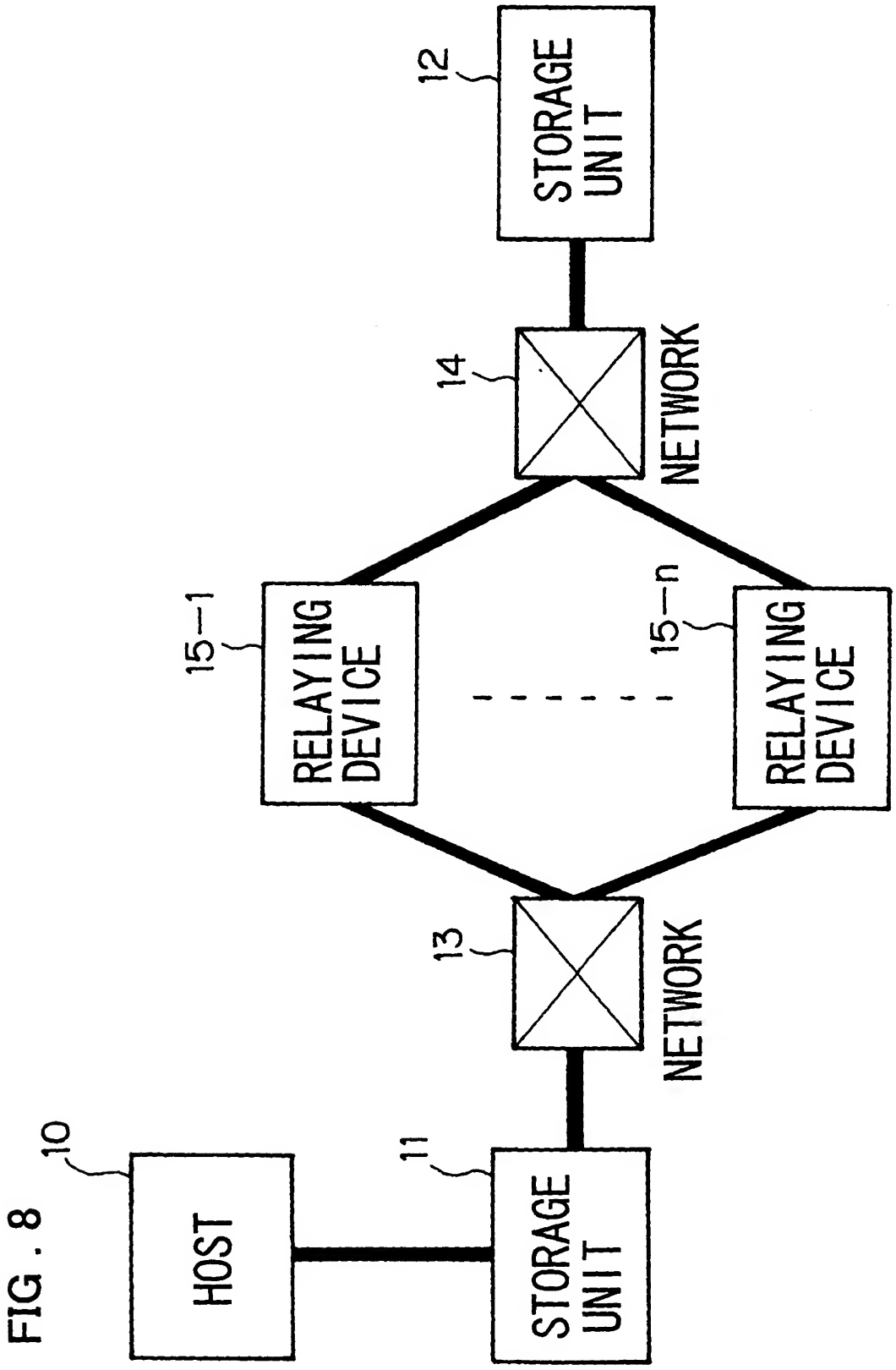

12
STORAGE UNIT
14
NETWORK
15—1
RELAYING DEVICE
15—n
RELAYING DEVICE
13
NETWORK
10
HOST
11
STORAGE UNIT

FIG. 8

FIG . 9

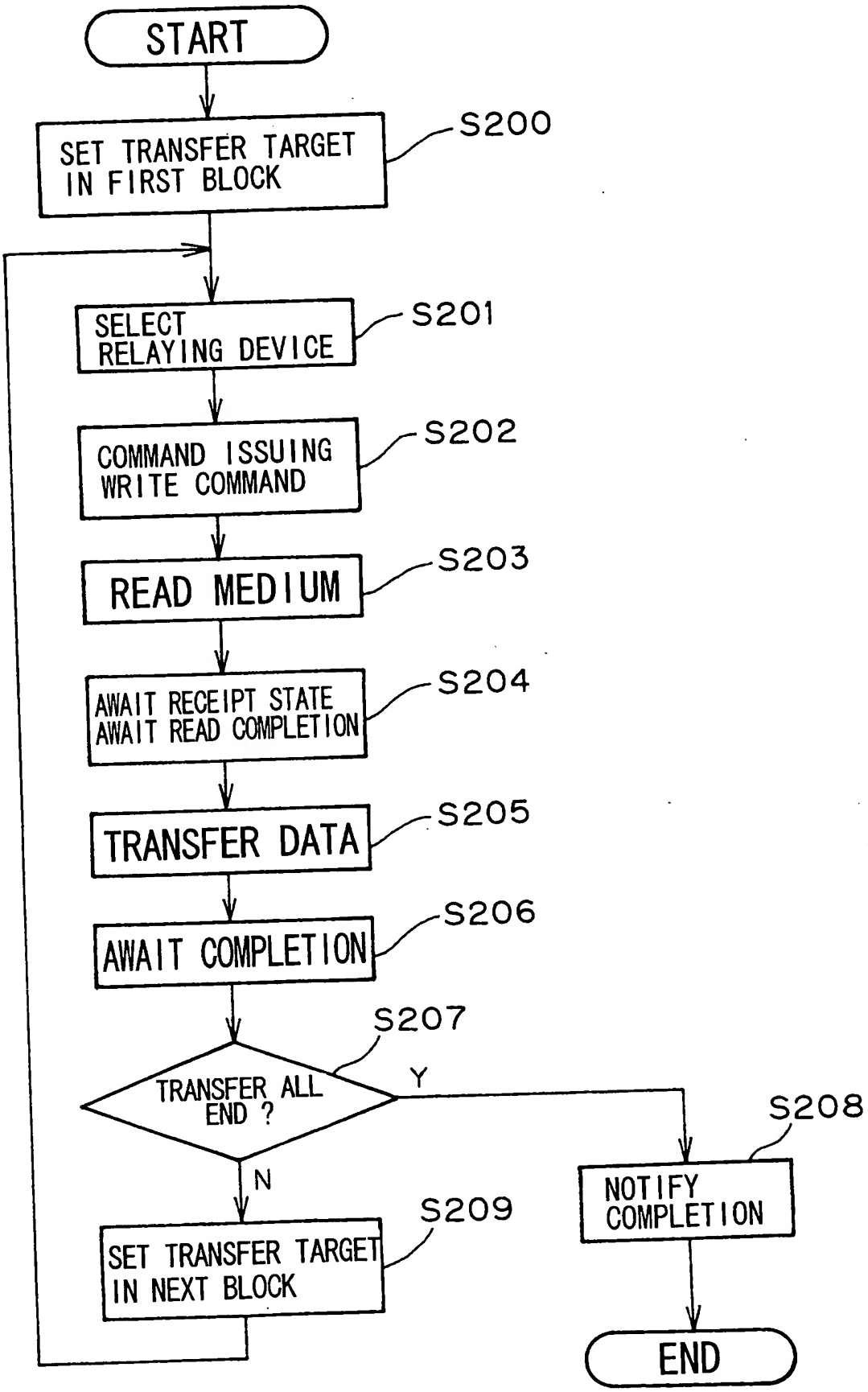

START
SET TRANSFER TARGET IN FIRST BLOCK
S200
SELECT RELAYING DEVICE
S201
COMMAND ISSUING WRITE COMMAND
S202
READ MEDIUM
S203
AWAIT RECEIPT STATE AWAIT READ COMPLETION
S204
TRANSFER DATA
S205
AWAIT COMPLETION
S206
S207
TRANSFER ALL END ?
Y
N
S208
NOTIFY COMPLETION
S209
SET TRANSFER TARGET IN NEXT BLOCK
END

FIG . 10

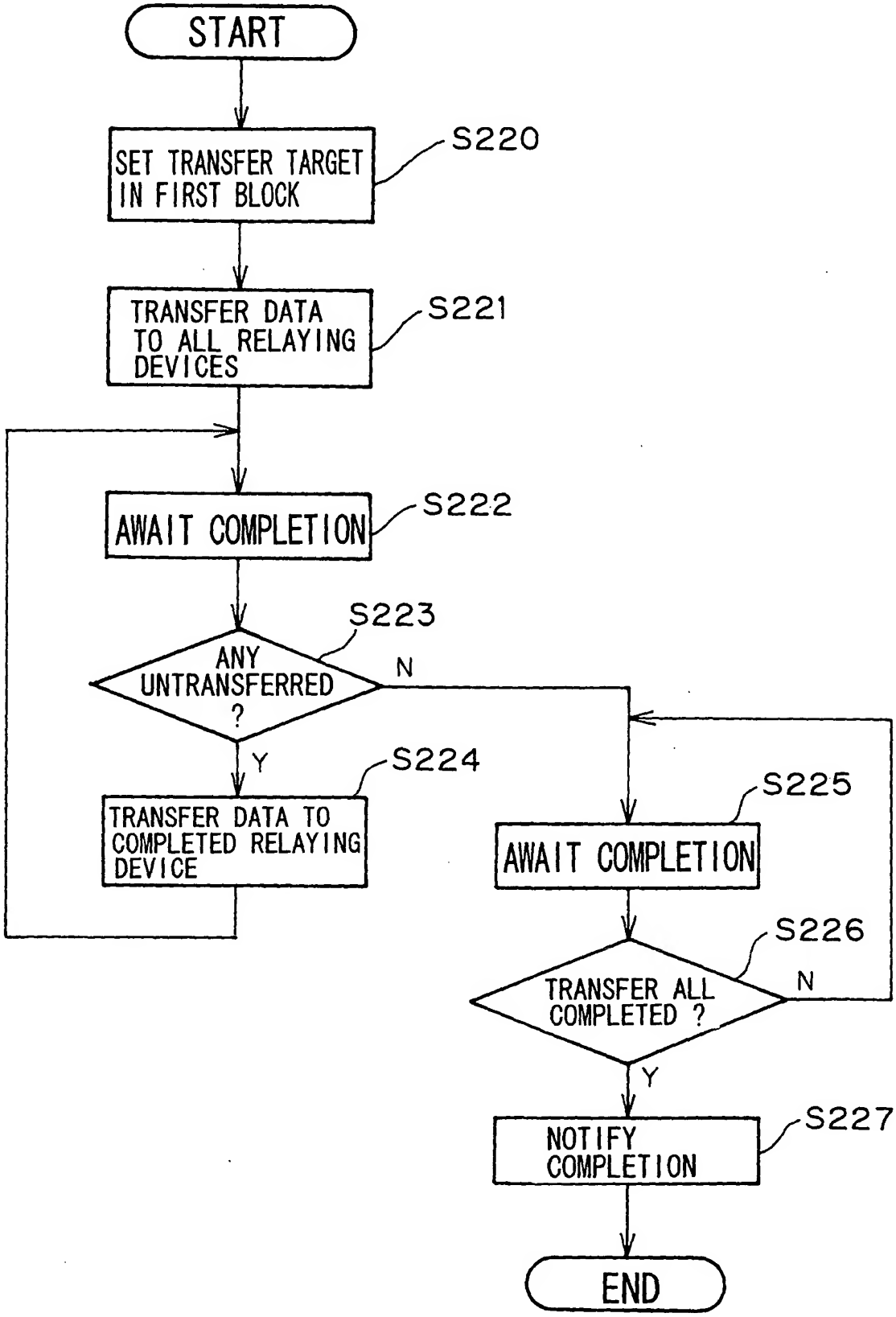

START
SET TRANSFER TARGET IN FIRST BLOCK
S220
TRANSFER DATA TO ALL RELAYING DEVICES
S221
AWAIT COMPLETION
S222
ANY UNTRANSFERRED ?
S223
N
Y
TRANSFER DATA TO COMPLETED RELAYING DEVICE
S224
AWAIT COMPLETION
S225
TRANSFER ALL COMPLETED ?
S226
N
Y
NOTIFY COMPLETION
S227
END

FIG . 11

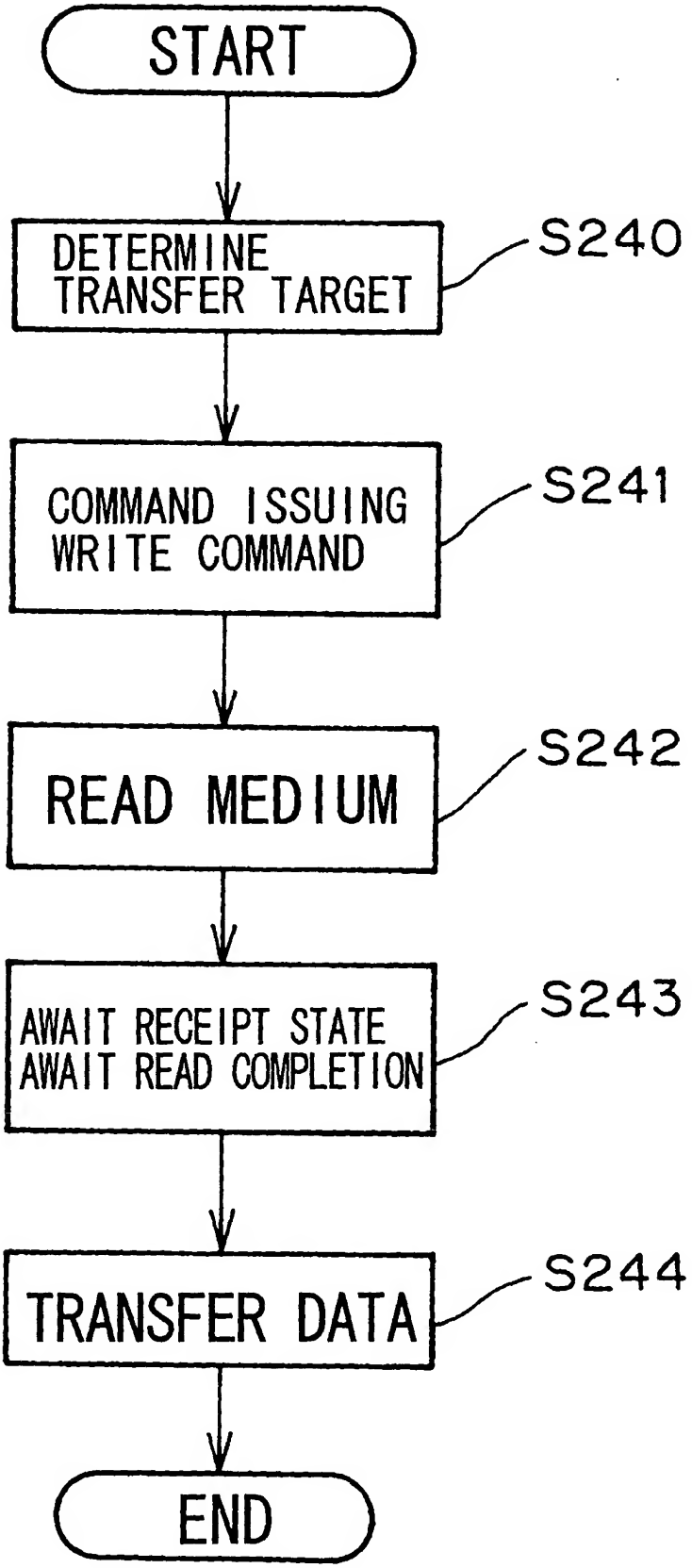

START
DETERMINE TRANSFER TARGET
S240
COMMAND ISSUING WRITE COMMAND
S241
READ MEDIUM
S242
AWAIT RECEIPT STATE AWAIT READ COMPLETION
S243
TRANSFER DATA
S244
END

FIG. 12

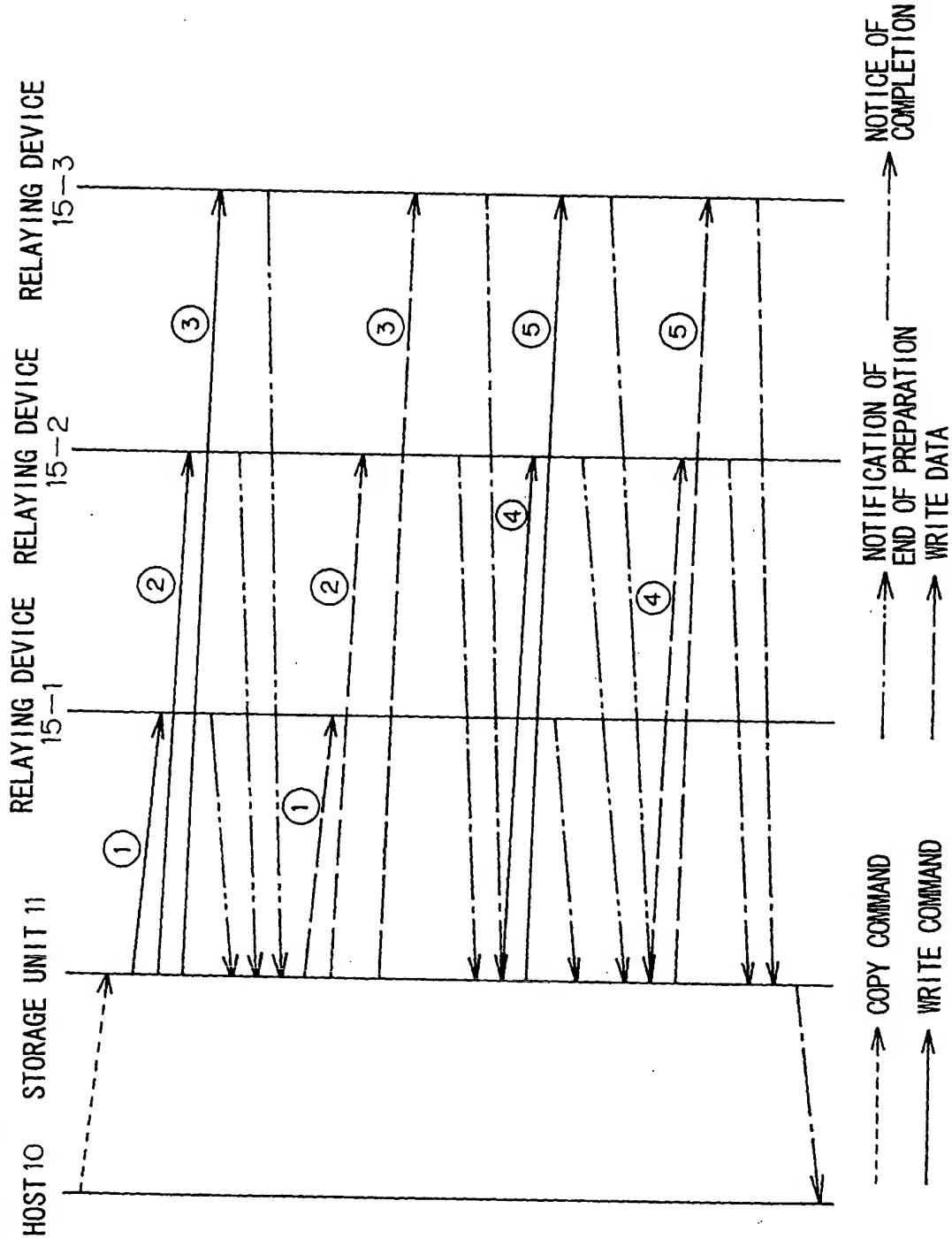

HOST 10
STORAGE UNIT 11
RELAYING DEVICE 15-1
RELAYING DEVICE 15-2
RELAYING DEVICE 15-3
COPY COMMAND
WRITE COMMAND
NOTIFICATION OF END OF PREPARATION
WRITE DATA
NOTICE OF COMPLETION

FIG . 13

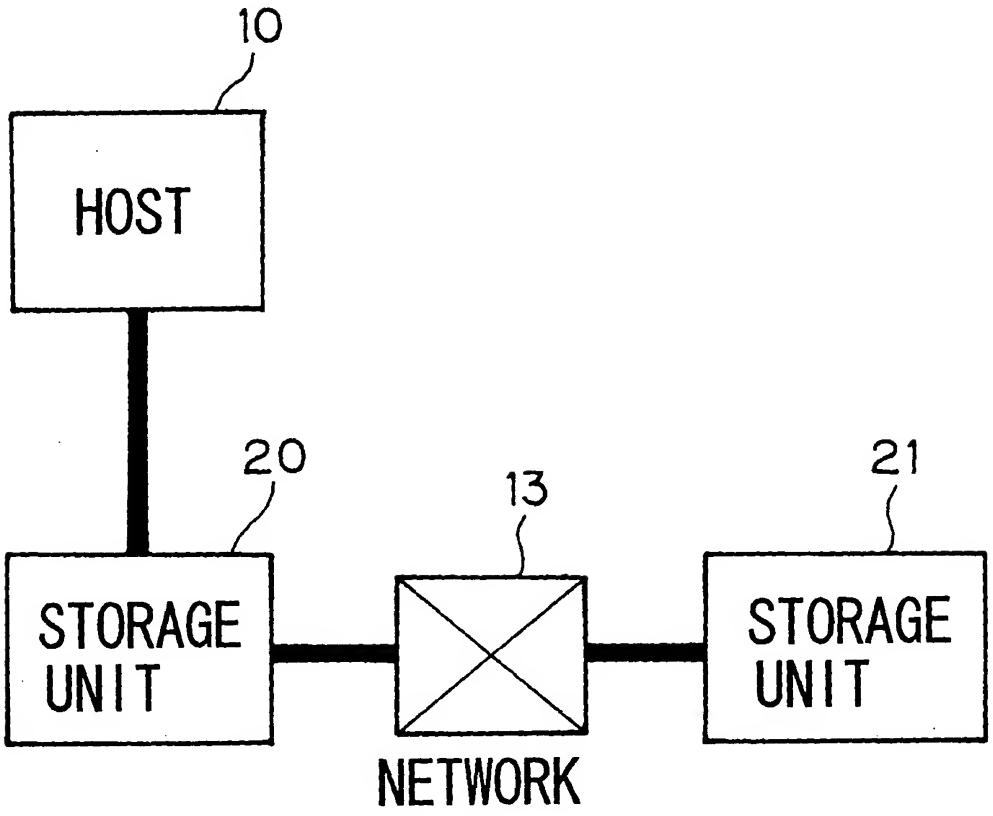


FIG .14

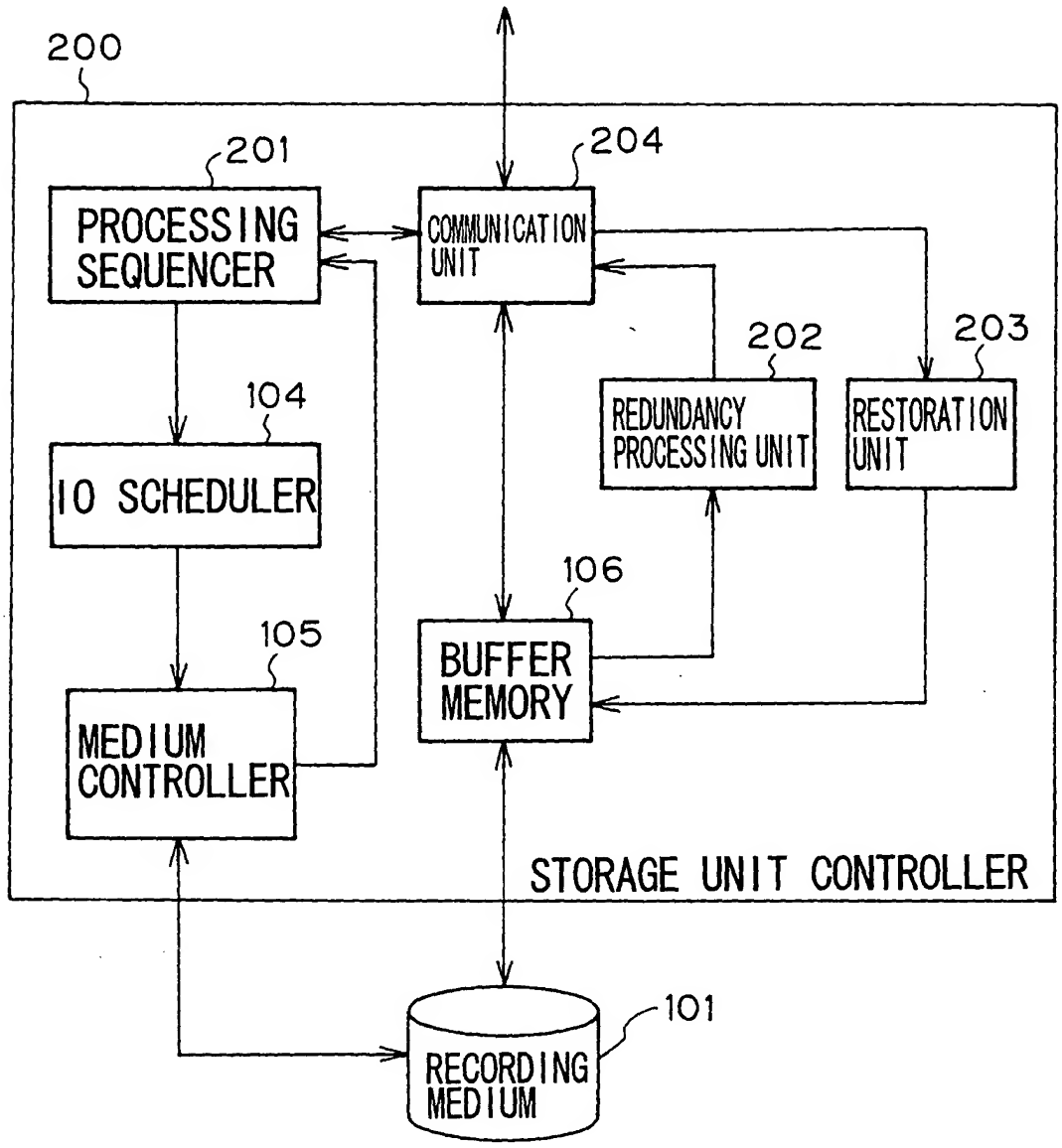

200
201
PROCESSING SEQUENCER
204
COMMUNICATION UNIT
202
203
REDUNDANCY PROCESSING UNIT
RESTORATION UNIT
104
IO SCHEDULER
106
105
BUFFER MEMORY
MEDIUM CONTROLLER
STORAGE UNIT CONTROLLER
101
RECORDING MEDIUM

FIG .15

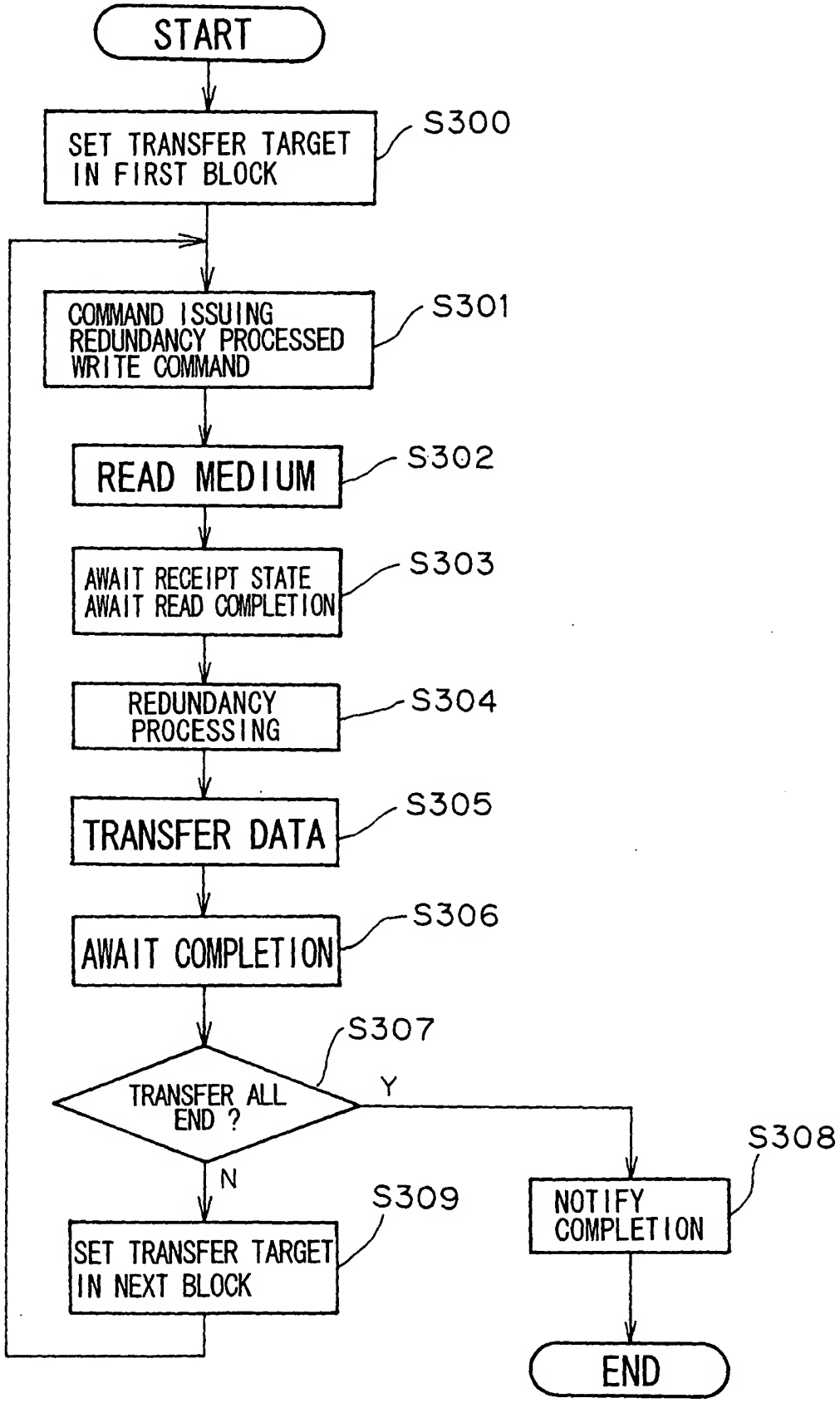

START
SET TRANSFER TARGET IN FIRST BLOCK
S300
COMMAND ISSUING REDUNDANCY PROCESSED WRITE COMMAND
S301
READ MEDIUM
S302
AWAIT RECEIPT STATE AWAIT READ COMPLETION
S303
REDUNDANCY PROCESSING
S304
TRANSFER DATA
S305
AWAIT COMPLETION
S306
TRANSFER ALL END ?
S307
Y
N
NOTIFY COMPLETION
S308
SET TRANSFER TARGET IN NEXT BLOCK
S309
END

FIG . 16

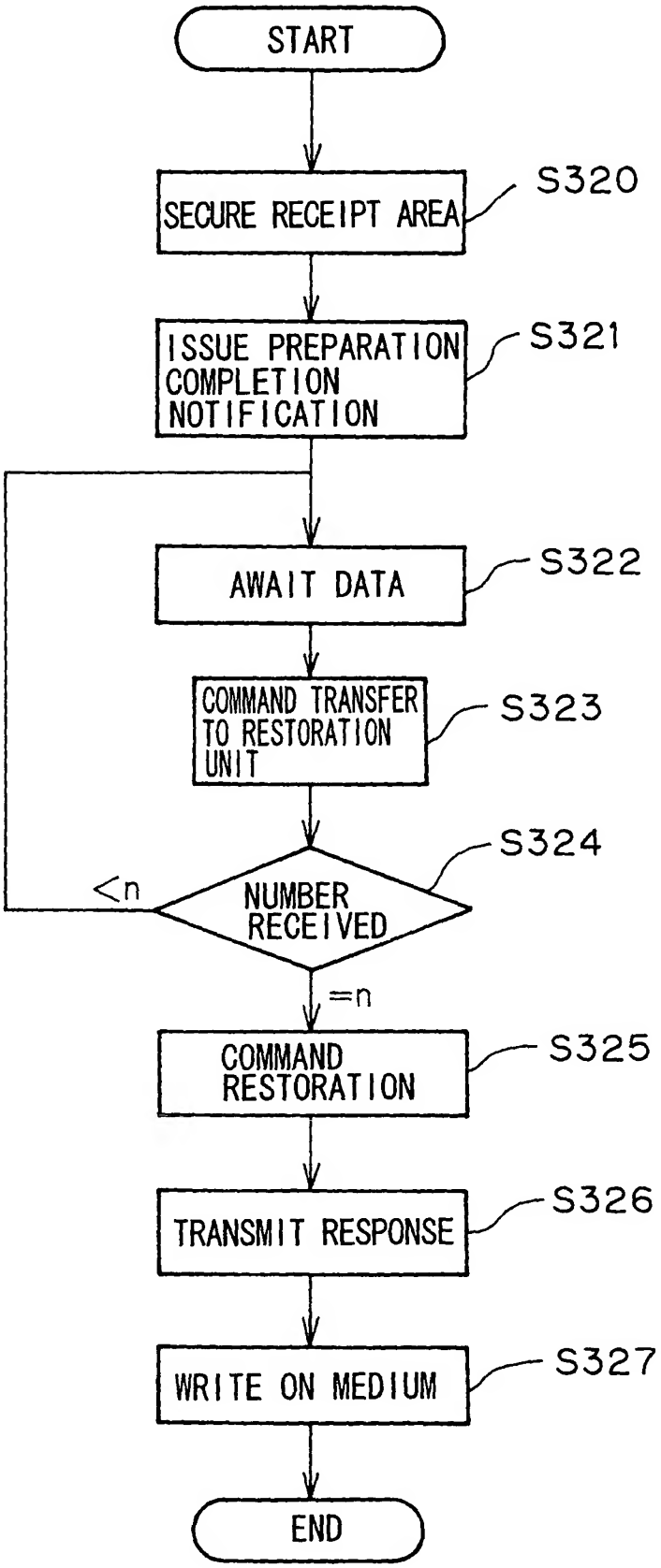

START
SECURE RECEIPT AREA
S320
ISSUE PREPARATION COMPLETION NOTIFICATION
S321
AWAIT DATA
S322
COMMAND TRANSFER TO RESTORATION UNIT
S323
NUMBER RECEIVED
S324
<n
=n
COMMAND RESTORATION
S325
TRANSMIT RESPONSE
S326
WRITE ON MEDIUM
S327
END

FIG . 17

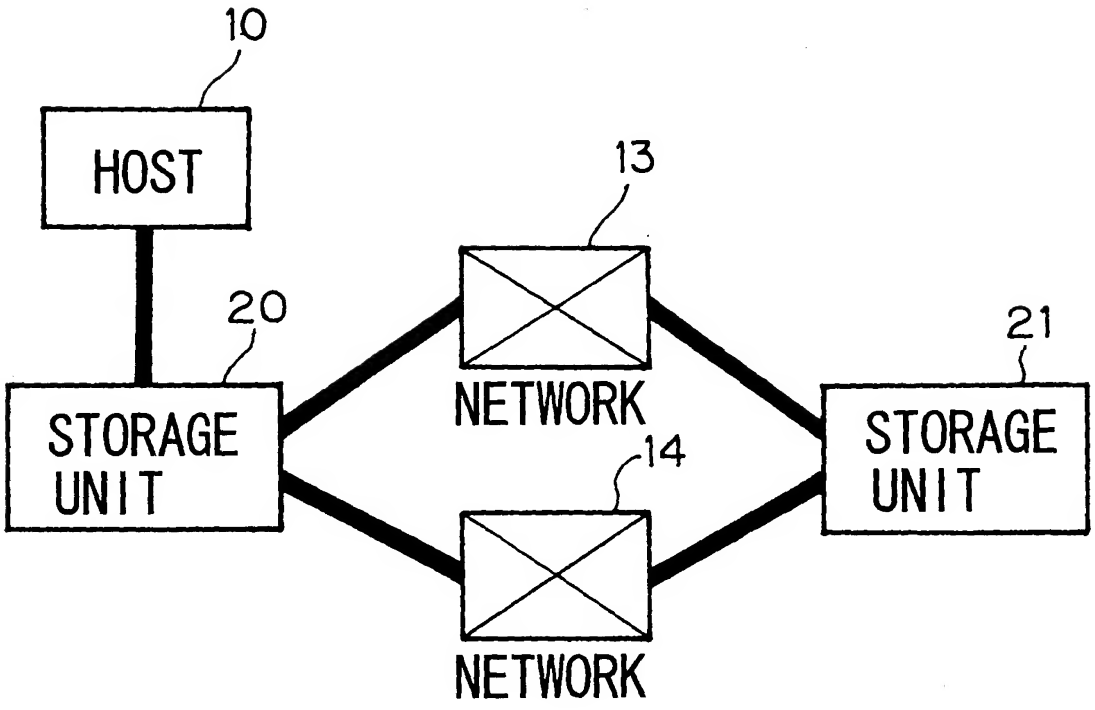

10
HOST
13
20
21
NETWORK
STORAGE UNIT
14
STORAGE UNIT
NETWORK

FIG . 18

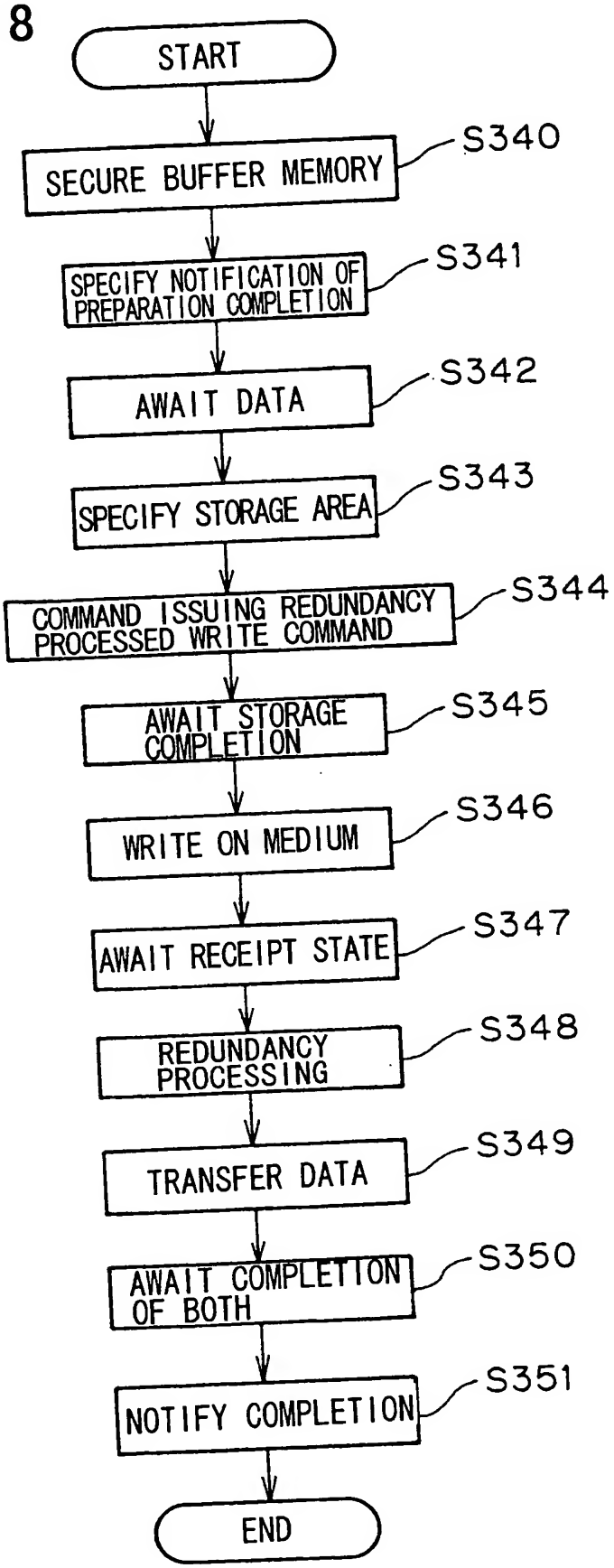

START
SECURE BUFFER MEMORY
S340
SPECIFY NOTIFICATION OF PREPARATION COMPLETION
S341
AWAIT DATA
S342
SPECIFY STORAGE AREA
S343
COMMAND ISSUING REDUNDANCY PROCESSED WRITE COMMAND
S344
AWAIT STORAGE COMPLETION
S345
WRITE ON MEDIUM
S346
AWAIT RECEIPT STATE
S347
REDUNDANCY PROCESSING
S348
TRANSFER DATA
S349
AWAIT COMPLETION OF BOTH
S350
NOTIFY COMPLETION
S351
END

FIG . 19

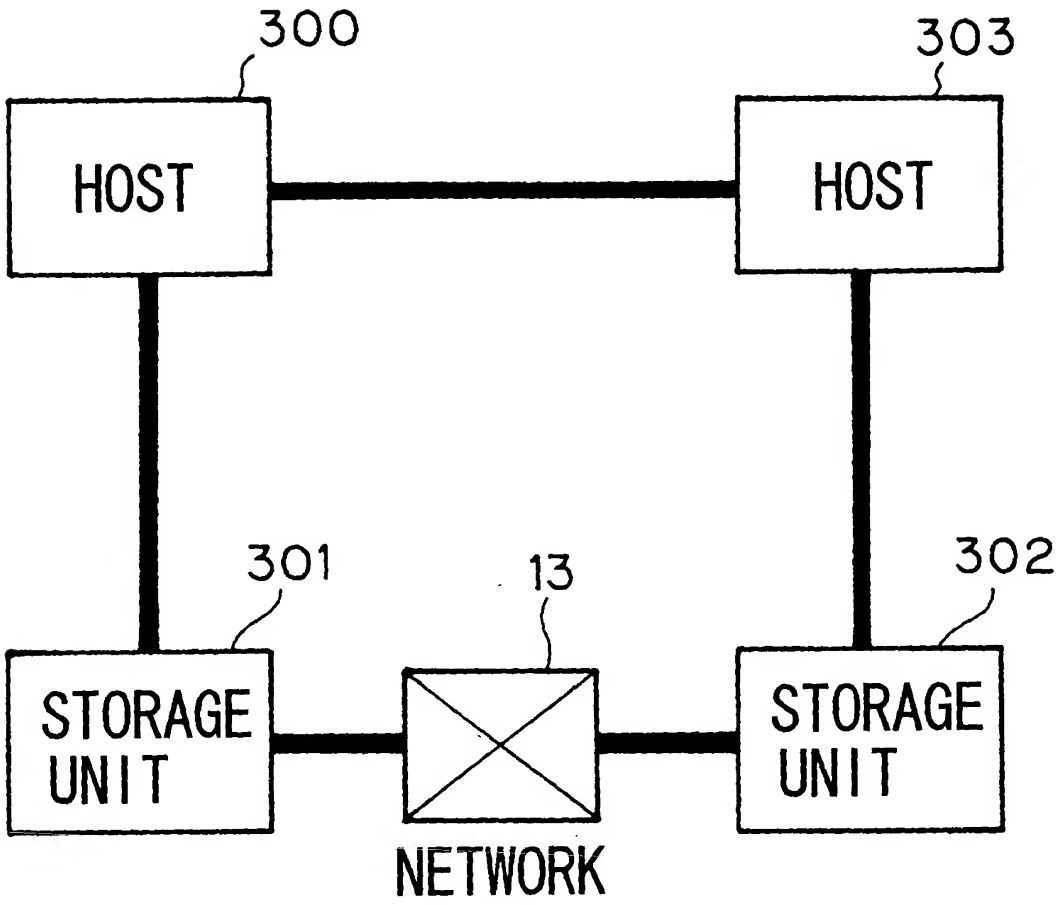

300
303
HOST
HOST
301
13
302
STORAGE UNIT
STORAGE UNIT
NETWORK

FIG . 20

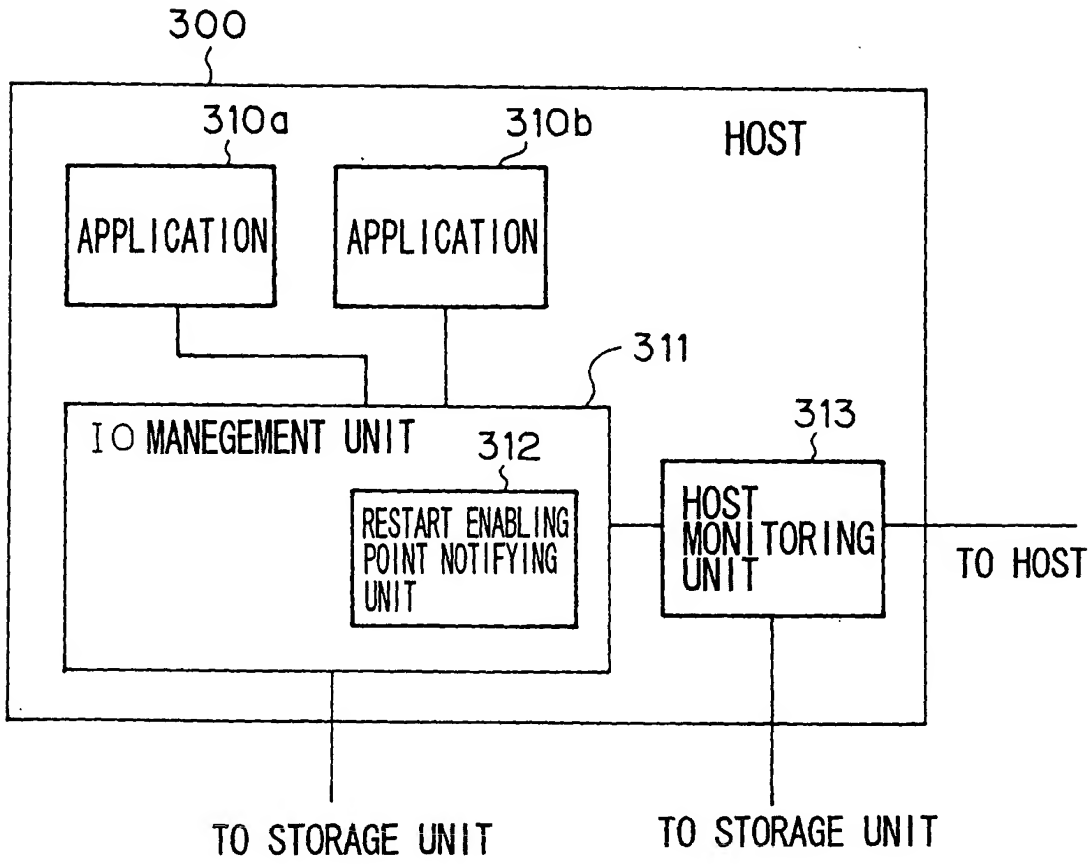

300
310a
310b
HOST
APPLICATION
APPLICATION
311
IO MANEGEMENT UNIT
312
RESTART ENABLING POINT NOTIFYING UNIT
313
HOST MONITORING UNIT
TO HOST
TO STORAGE UNIT
TO STORAGE UNIT

FIG . 21

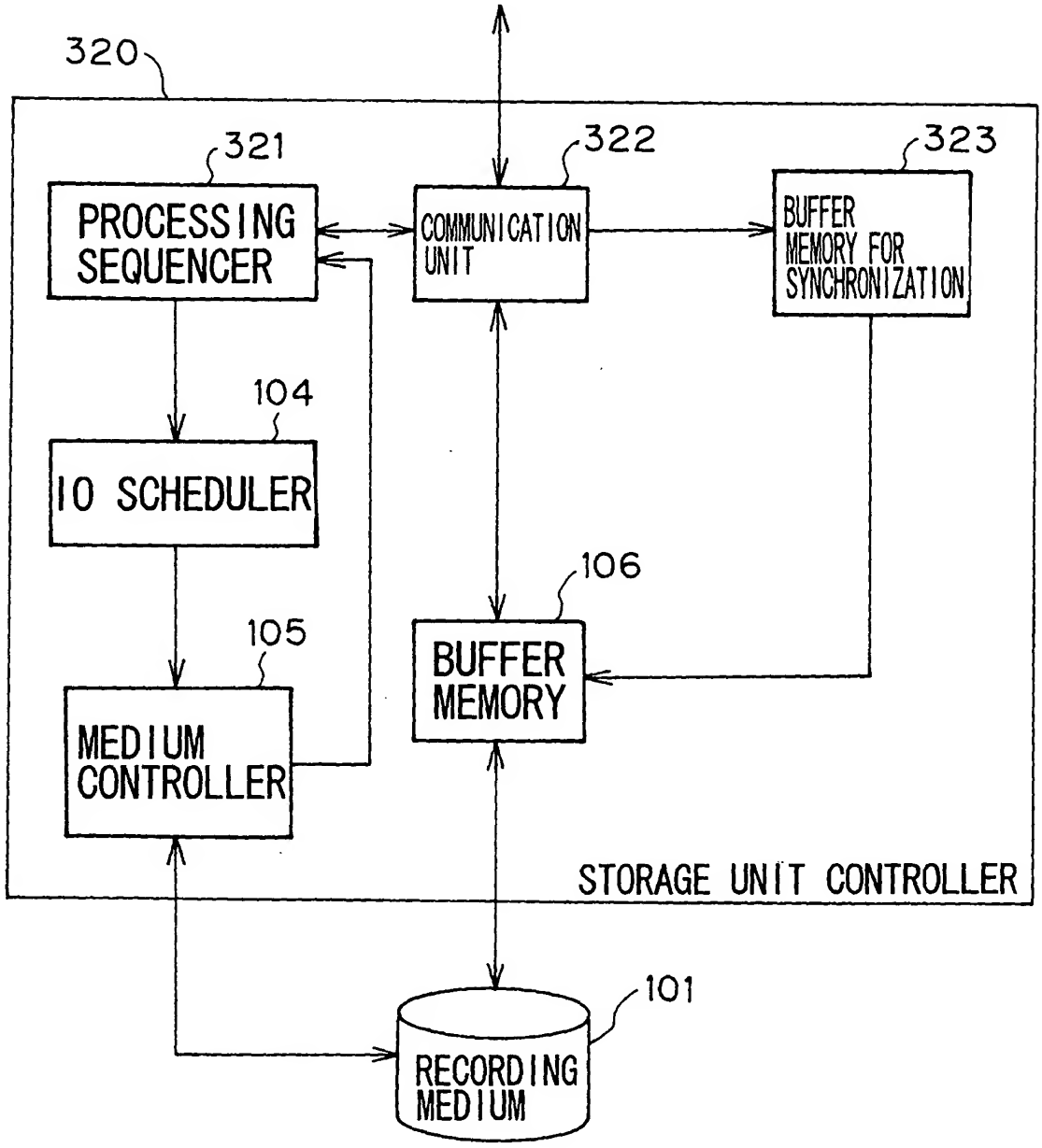

320
321
322
323
PROCESSING SEQUENCER
COMMUNICATION UNIT
BUFFER MEMORY FOR SYNCHRONIZATION
104
IO SCHEDULER
106
105
BUFFER MEMORY
MEDIUM CONTROLLER
STORAGE UNIT CONTROLLER
101
RECORDING MEDIUM

FIG. 22

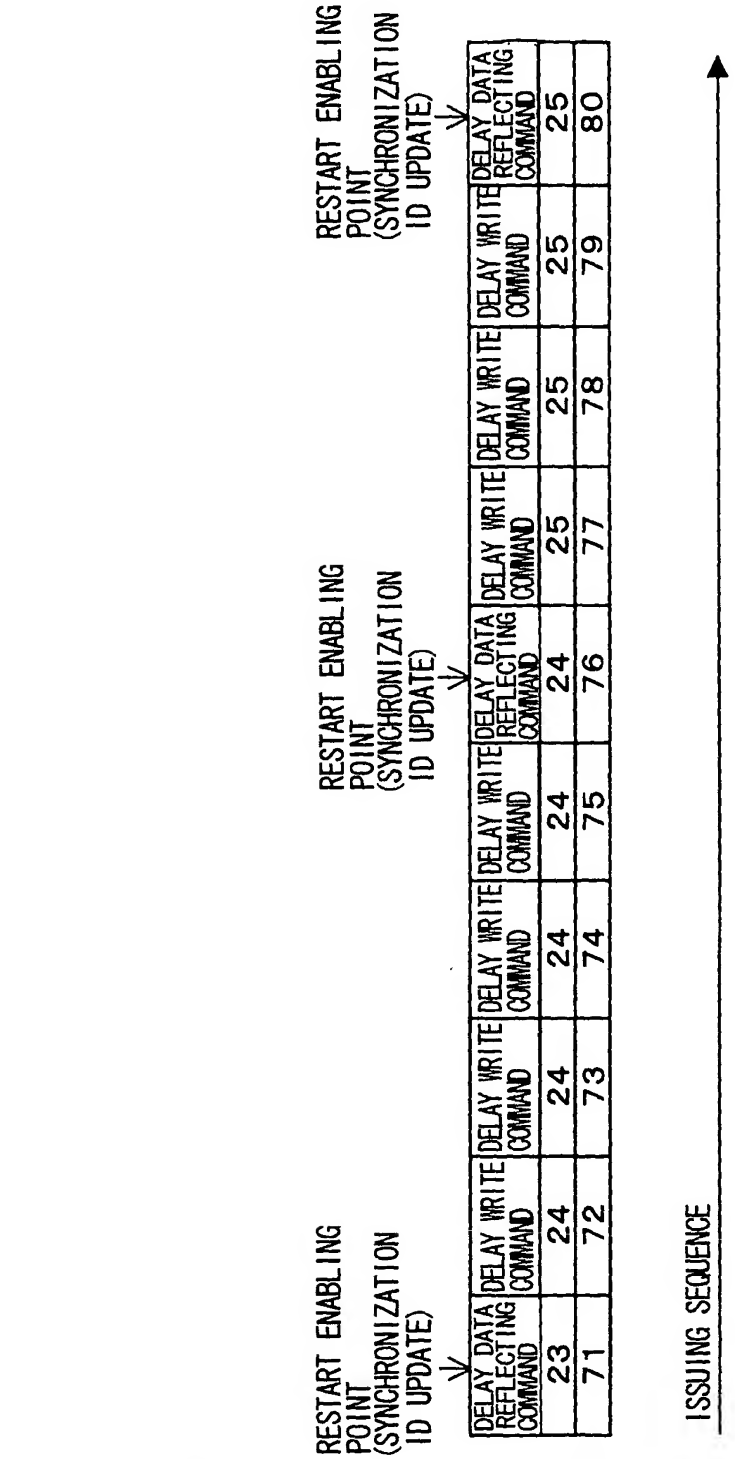

RESTART ENABLING POINT (SYNCHRONIZATION ID UPDATE)
RESTART ENABLING POINT (SYNCHRONIZATION ID UPDATE)
RESTART ENABLING POINT (SYNCHRONIZATION ID UPDATE)
DELAY DATA REFLECTING COMMAND
DELAY WRITE COMMAND
SYNCHRONIZATION ID
ISSUING ID
23
24
71
72
24
73
24
74
24
75
24
76
25
77
25
78
25
79
25
80
ISSUING SEQUENCE

FIG . 23

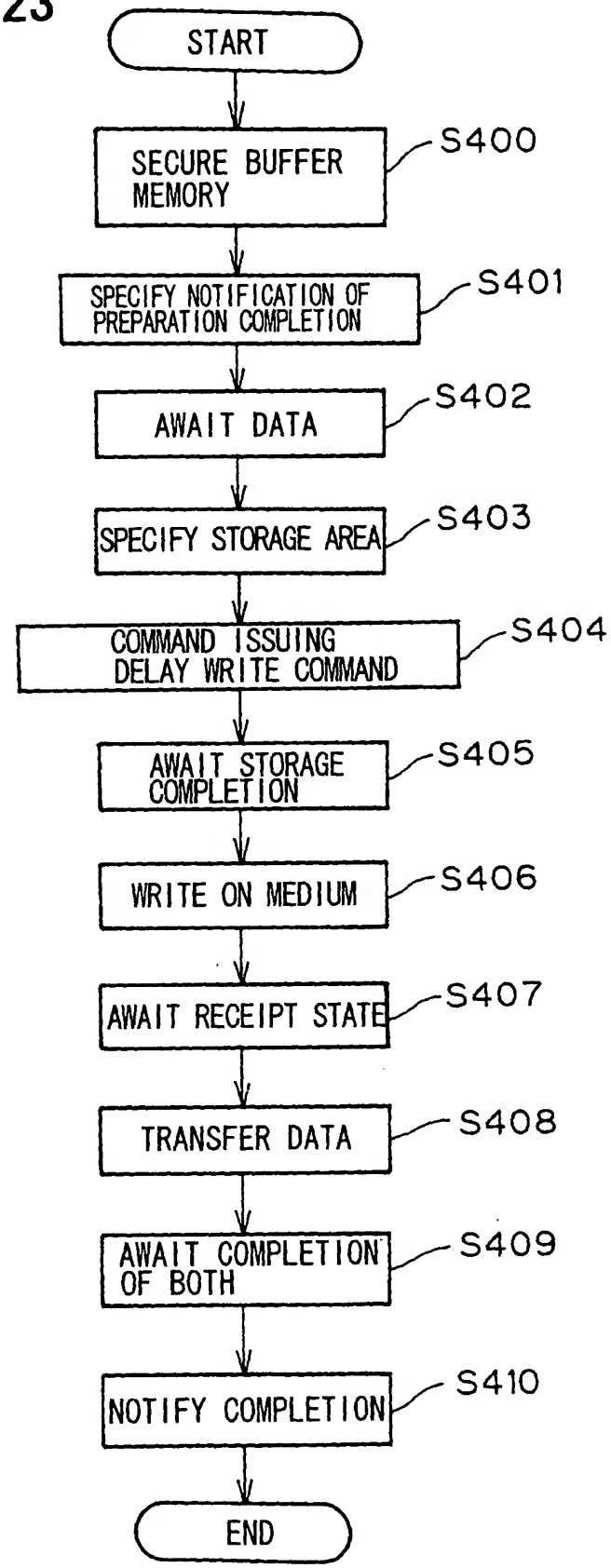

START
SECURE BUFFER MEMORY
S400
SPECIFY NOTIFICATION OF PREPARATION COMPLETION
S401
AWAIT DATA
S402
SPECIFY STORAGE AREA
S403
COMMAND ISSUING DELAY WRITE COMMAND
S404
AWAIT STORAGE COMPLETION
S405
WRITE ON MEDIUM
S406
AWAIT RECEIPT STATE
S407
TRANSFER DATA
S408
AWAIT COMPLETION OF BOTH
S409
NOTIFY COMPLETION
S410
END

FIG . 24

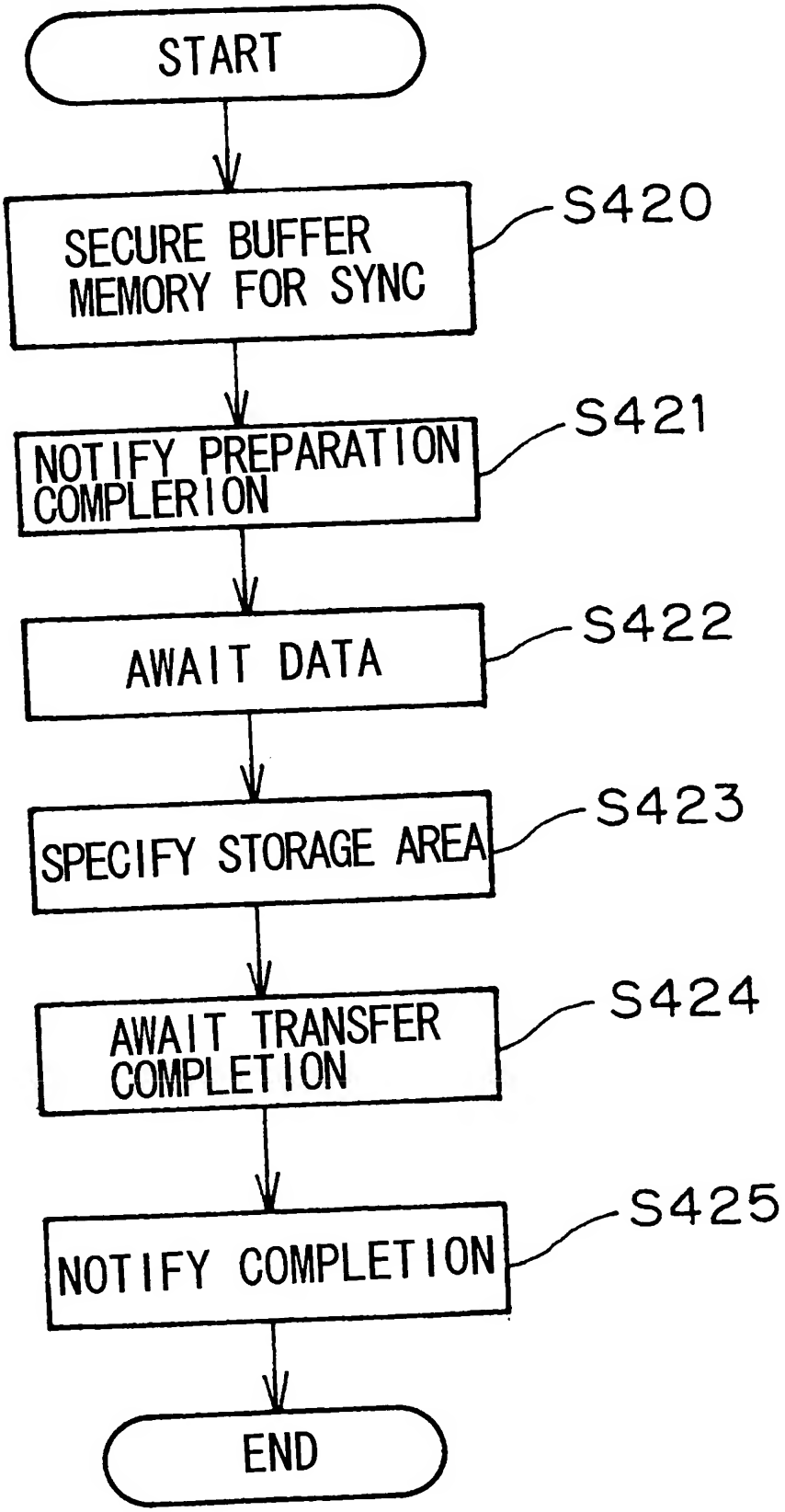

START
SECURE BUFFER MEMORY FOR SYNC
S420
NOTIFY PREPARATION COMPLERION
S421
AWAIT DATA
S422
SPECIFY STORAGE AREA
S423
AWAIT TRANSFER COMPLETION
S424
NOTIFY COMPLETION
S425
END

FIG . 25

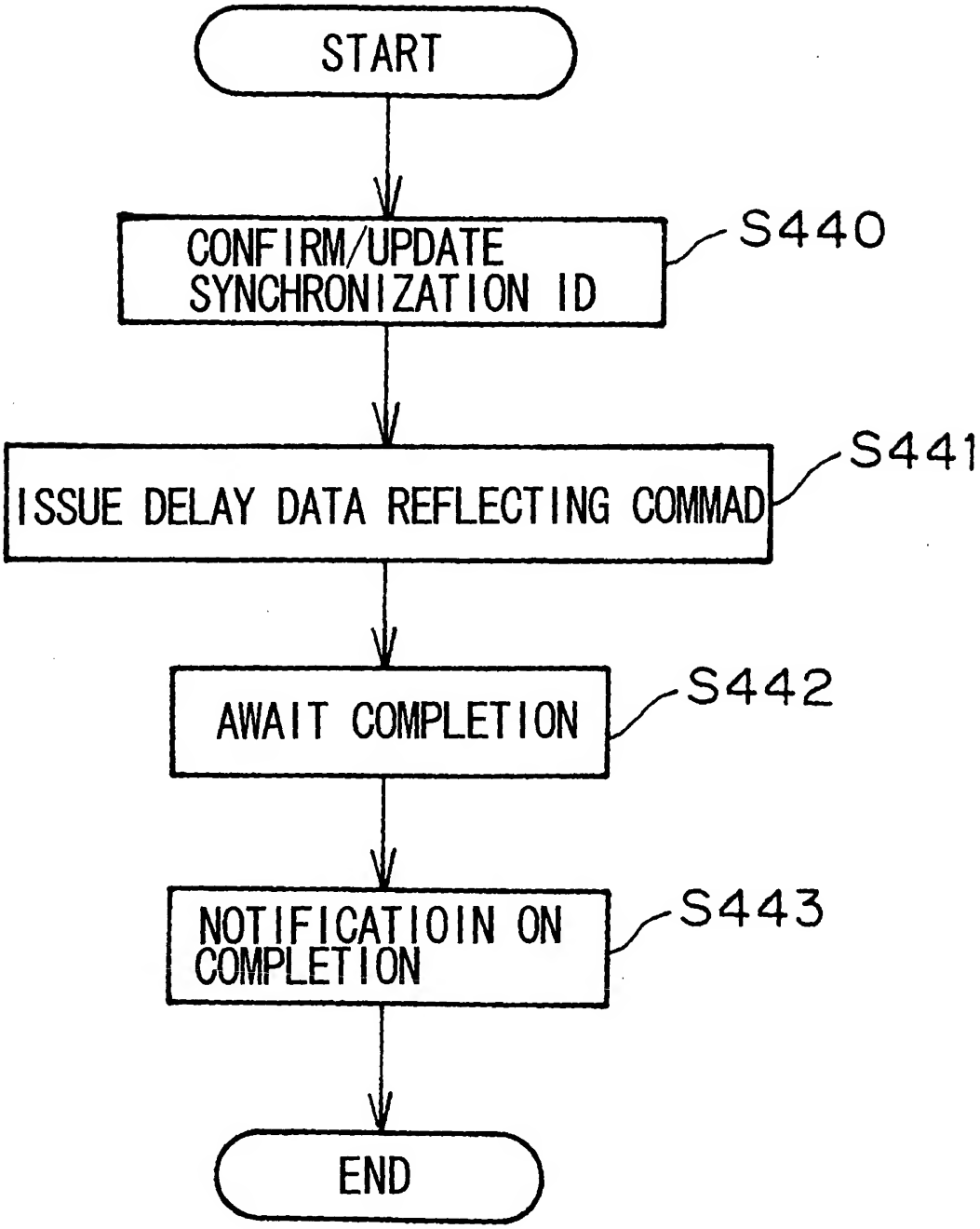

START
CONFIRM/UPDATE SYNCHRONIZATION ID
S440
ISSUE DELAY DATA REFLECTING COMMAD
S441
AWAIT COMPLETION
S442
NOTIFICATIOIN ON COMPLETION
S443
END

FIG . 26

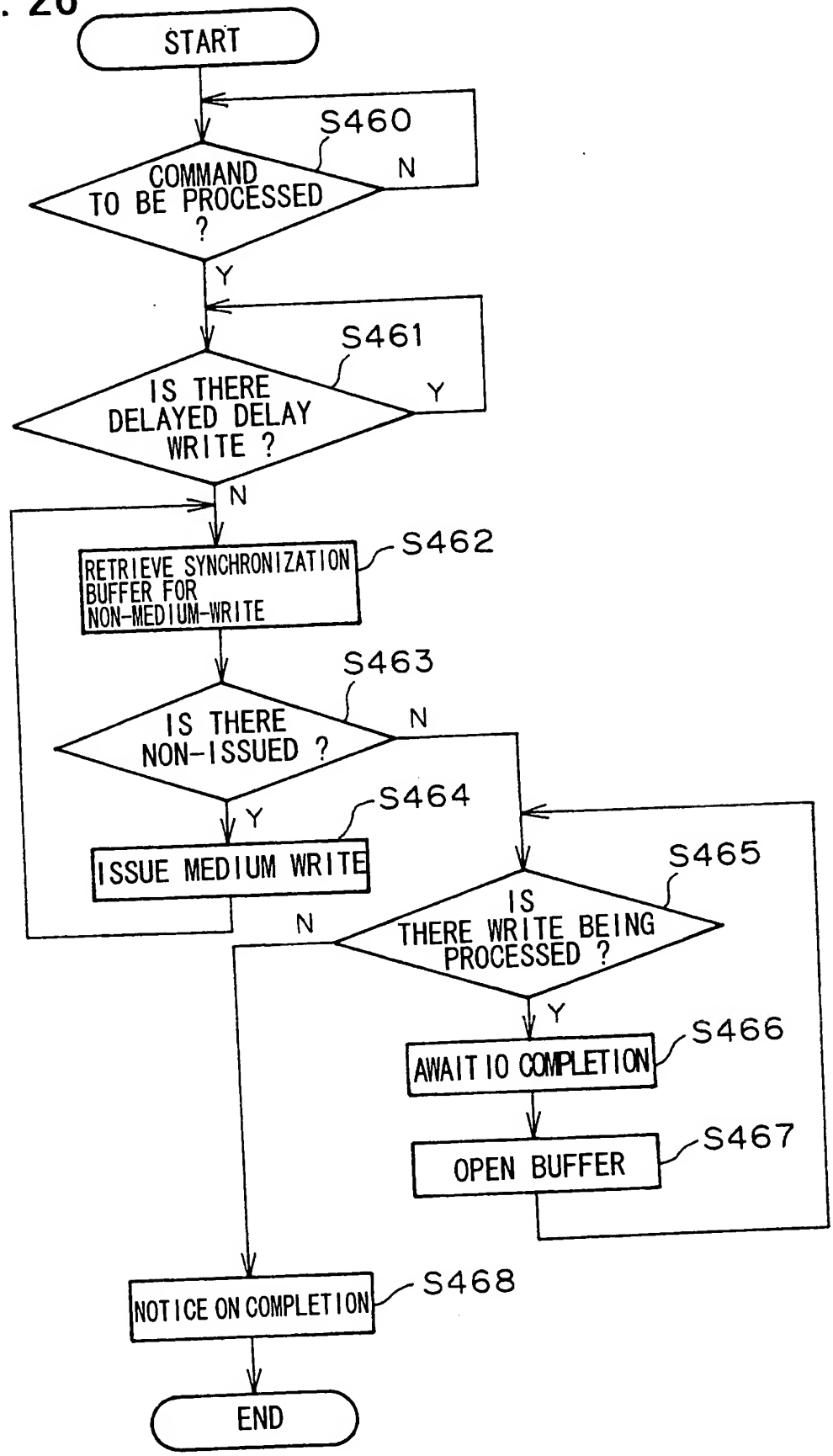

START
S460
COMMAND TO BE PROCESSED ?
N
Y
S461
IS THERE DELAYED DELAY WRITE ?
Y
N
S462
RETRIEVE SYNCHRONIZATION BUFFER FOR NON-MEDIUM-WRITE
S463
IS THERE NON-ISSUED ?
N
Y
S464
ISSUE MEDIUM WRITE
S465
IS THERE WRITE BEING PROCESSED ?
N
Y
S466
AWAIT IO COMPLETION
S467
OPEN BUFFER
S468
NOTICE ON COMPLETION
END

FIG . 27

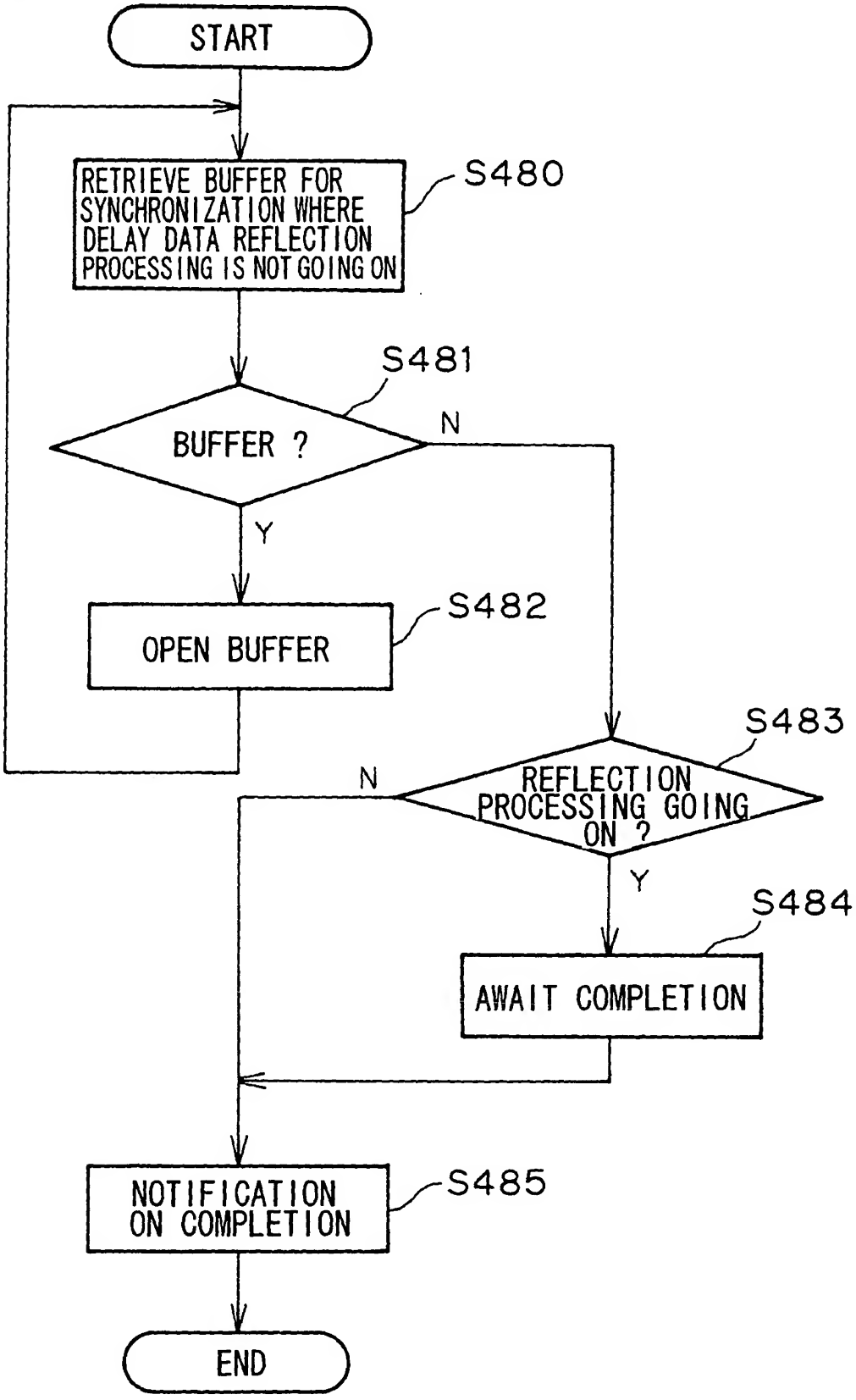

START
RETRIEVE BUFFER FOR SYNCHRONIZATION WHERE DELAY DATA REFLECTION PROCESSING IS NOT GOING ON
S480
S481
BUFFER ?
N
Y
OPEN BUFFER
S482
S483
N
REFLECTION PROCESSING GOING ON ?
Y
S484
AWAIT COMPLETION
NOTIFICATION ON COMPLETION
S485
END

FIG . 28

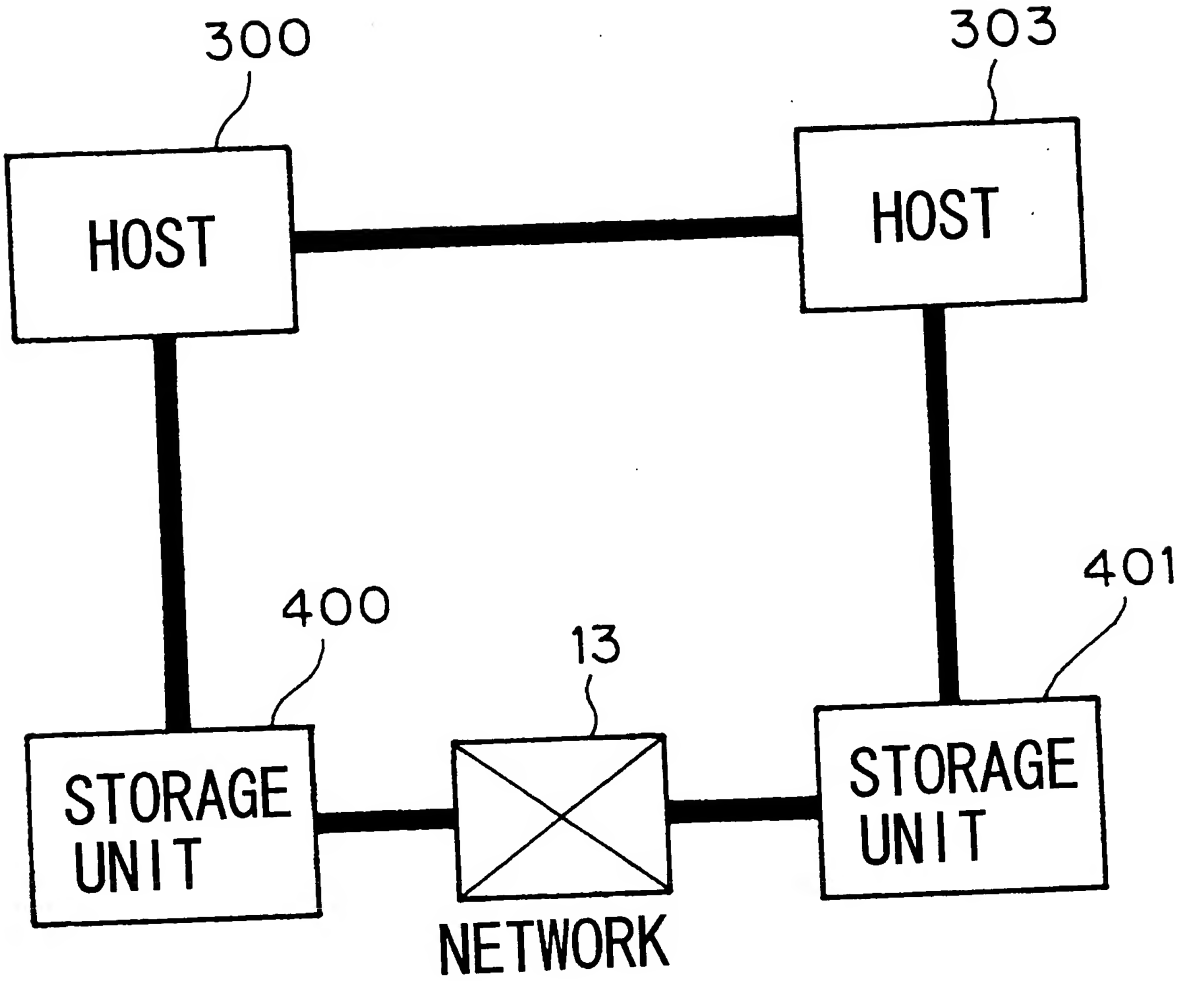

300
303
HOST
HOST
400
13
401
STORAGE UNIT
STORAGE UNIT
NETWORK

FIG . 29

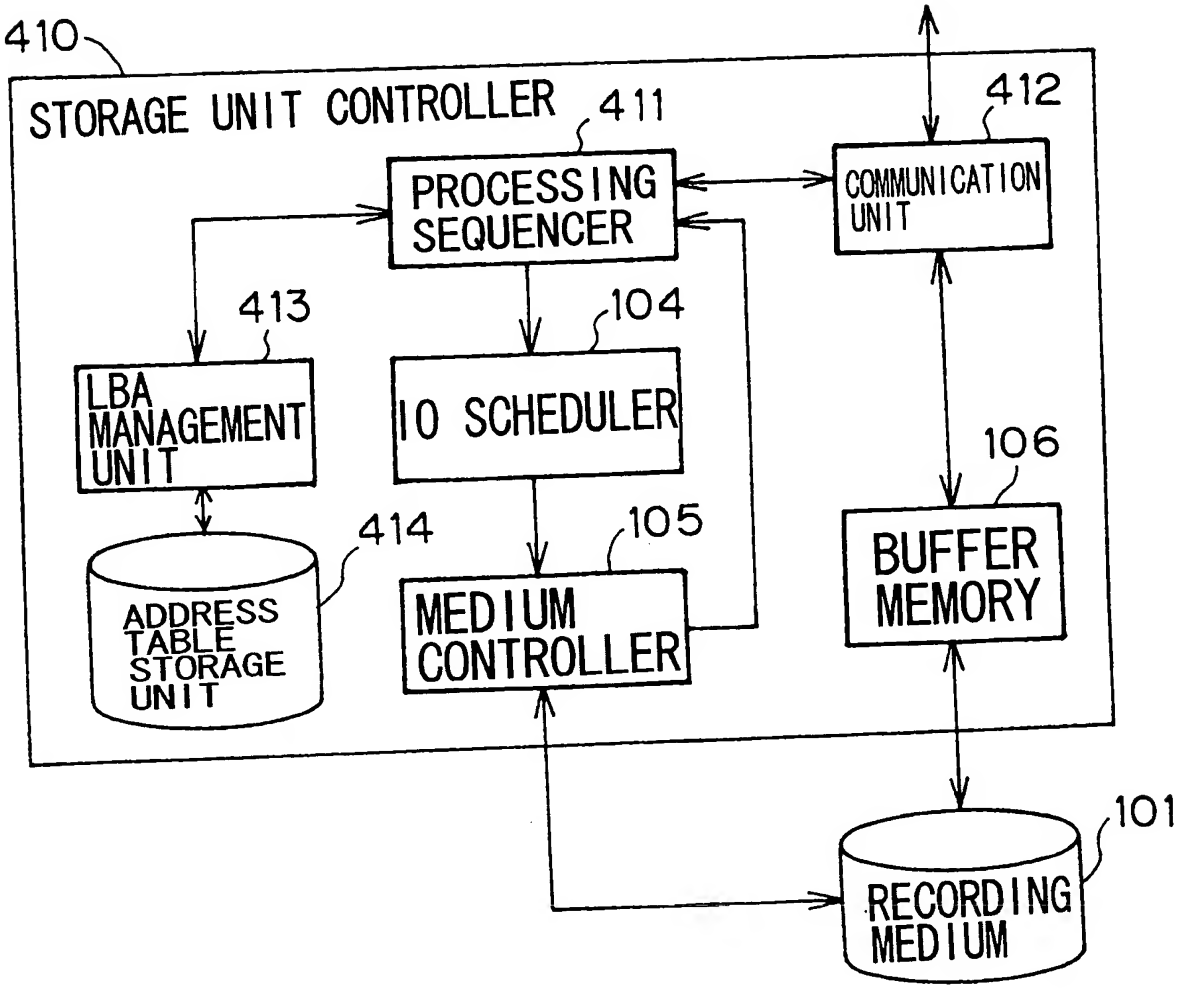

410
STORAGE UNIT CONTROLLER
411
412
PROCESSING SEQUENCER
COMMUNICATION UNIT
413
104
LBA MANAGEMENT UNIT
IO SCHEDULER
106
414
105
ADDRESS TABLE STORAGE UNIT
MEDIUM CONTROLLER
BUFFER MEMORY
101
RECORDING MEDIUM

FIG . 30

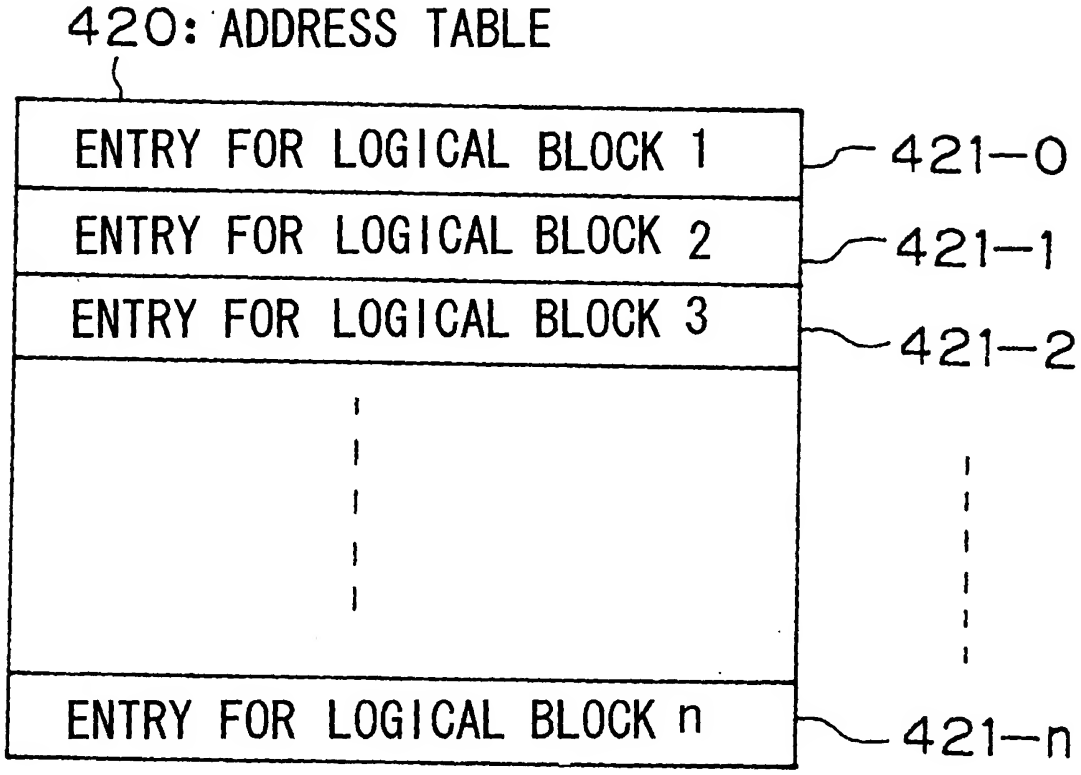

420: ADDRESS TABLE
ENTRY FOR LOGICAL BLOCK 1
ENTRY FOR LOGICAL BLOCK 2
ENTRY FOR LOGICAL BLOCK 3
ENTRY FOR LOGICAL BLOCK n
421—0
421—1
421—2
421—n

FIG . 31A

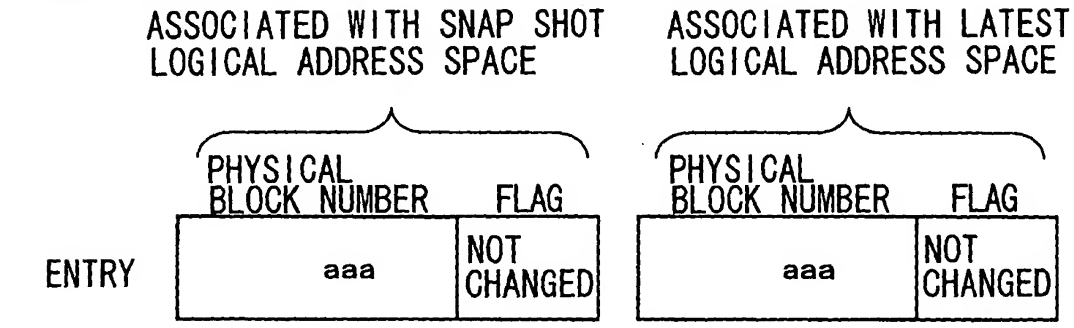


FIG . 31B

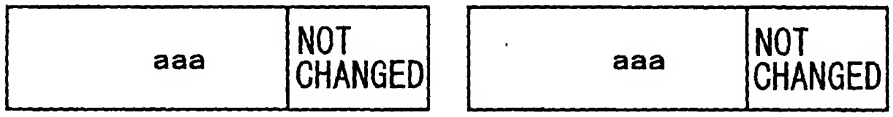


FIG . 31C

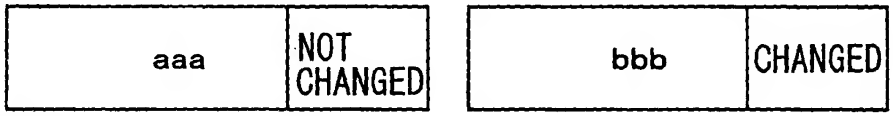


FIG . 31D

FIG . 32

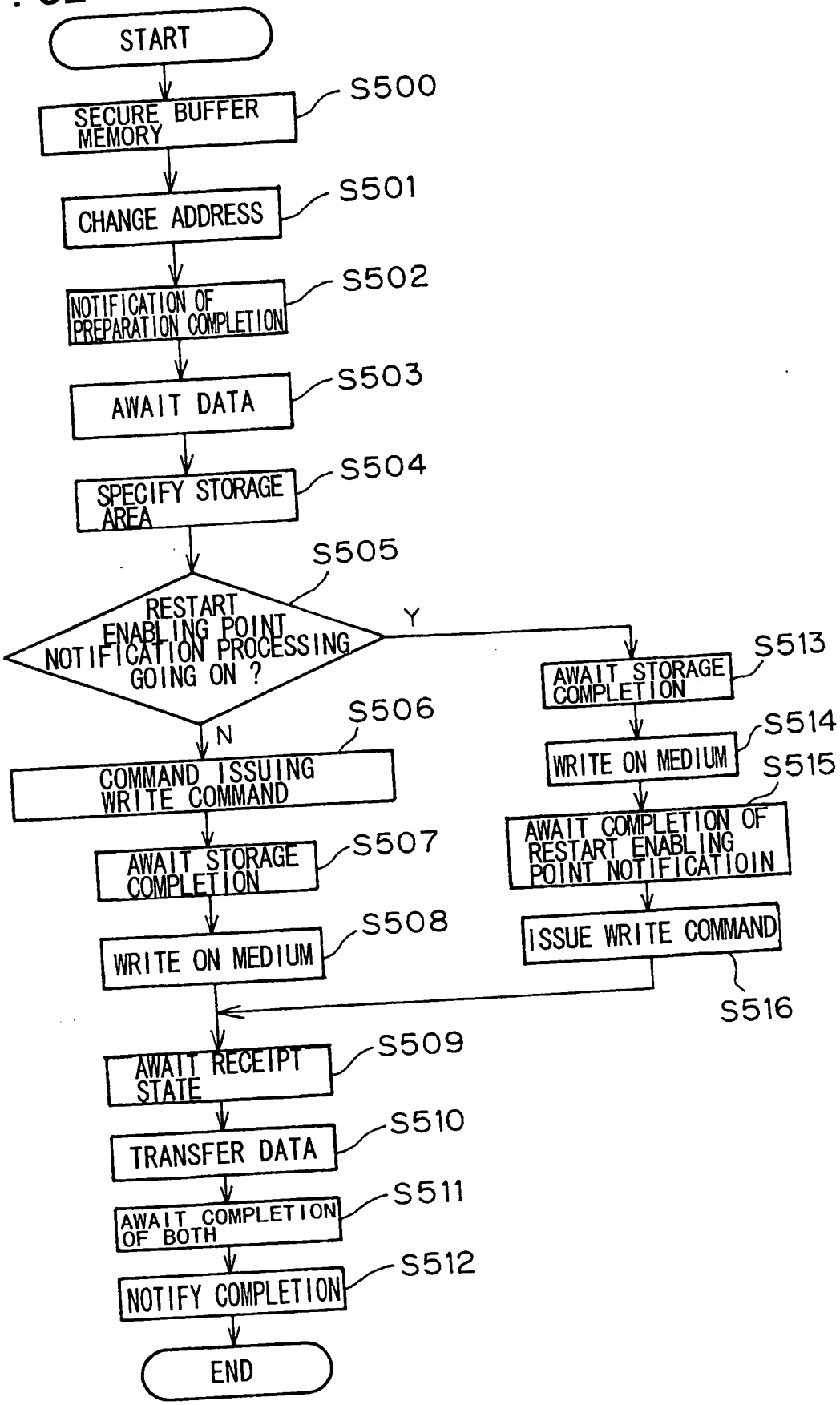

START
SECURE BUFFER MEMORY
S500
CHANGE ADDRESS
S501
NOTIFICATION OF PREPARATION COMPLETION
S502
AWAIT DATA
S503
SPECIFY STORAGE AREA
S504
RESTART ENABLING POINT NOTIFICATION PROCESSING GOING ON ?
S505
Y
N
AWAIT STORAGE COMPLETION
S513
WRITE ON MEDIUM
S514
AWAIT COMPLETION OF RESTART ENABLING POINT NOTIFICATIOIN
S515
ISSUE WRITE COMMAND
S516
COMMAND ISSUING WRITE COMMAND
S506
AWAIT STORAGE COMPLETION
S507
WRITE ON MEDIUM
S508
AWATT RECEIPT STATE
S509
TRANSFER DATA
S510
AWAIT COMPLETION OF BOTH
S511
NOTIFY COMPLETION
S512
END

FIG . 33

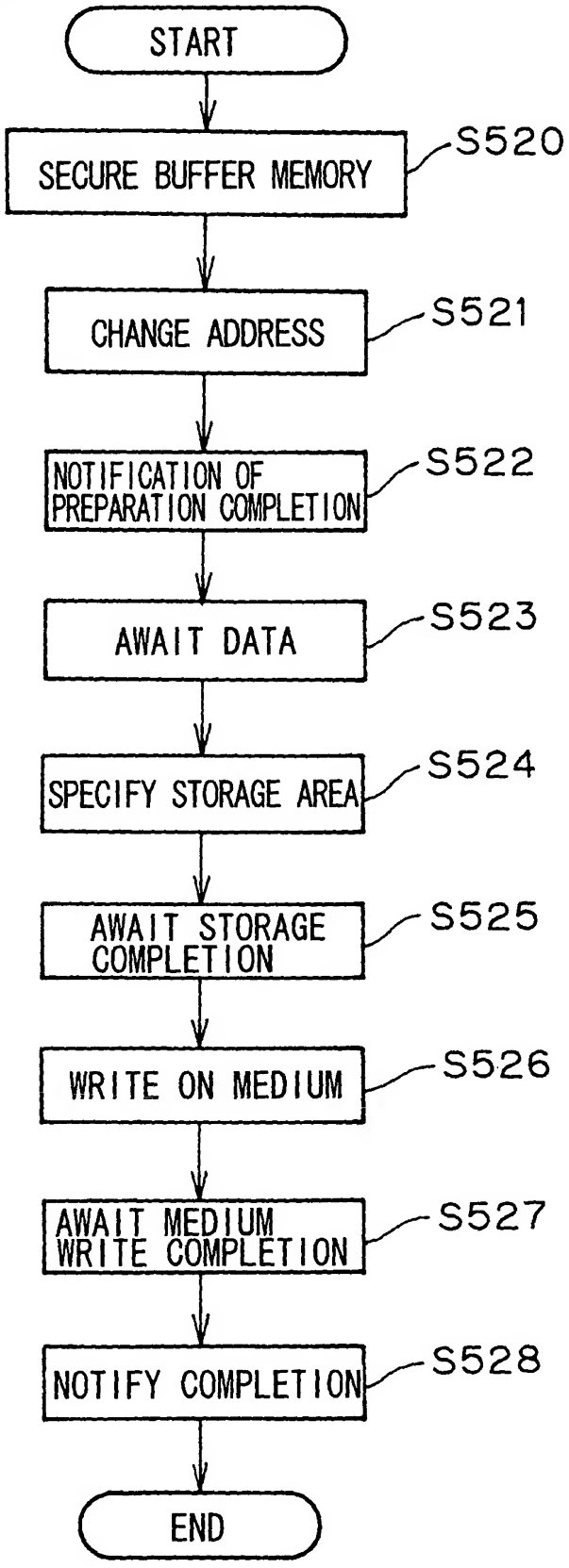

START
SECURE BUFFER MEMORY
S520
CHANGE ADDRESS
S521
NOTIFICATION OF PREPARATION COMPLETION
S522
AWAIT DATA
S523
SPECIFY STORAGE AREA
S524
AWAIT STORAGE COMPLETION
S525
WRITE ON MEDIUM
S526
AWAIT MEDIUM WRITE COMPLETION
S527
NOTIFY COMPLETION
S528
END

FIG . 34

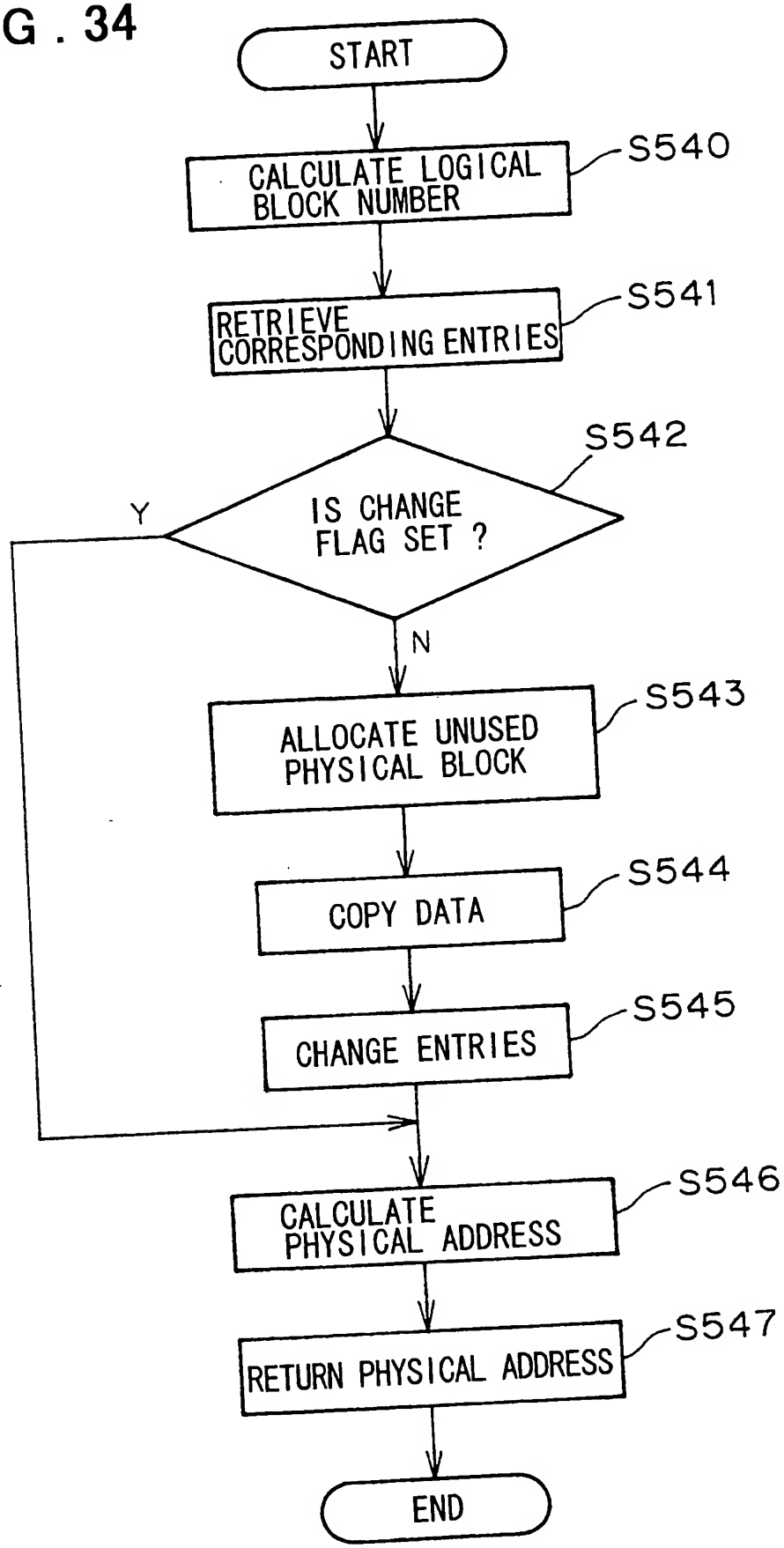

START
CALCULATE LOGICAL BLOCK NUMBER
S540
RETRIEVE CORRESPONDING ENTRIES
S541
S542
IS CHANGE FLAG SET ?
Y
N
ALLOCATE UNUSED PHYSICAL BLOCK
S543
COPY DATA
S544
CHANGE ENTRIES
S545
CALCULATE PHYSICAL ADDRESS
S546
RETURN PHYSICAL ADDRESS
S547
END

FIG . 35

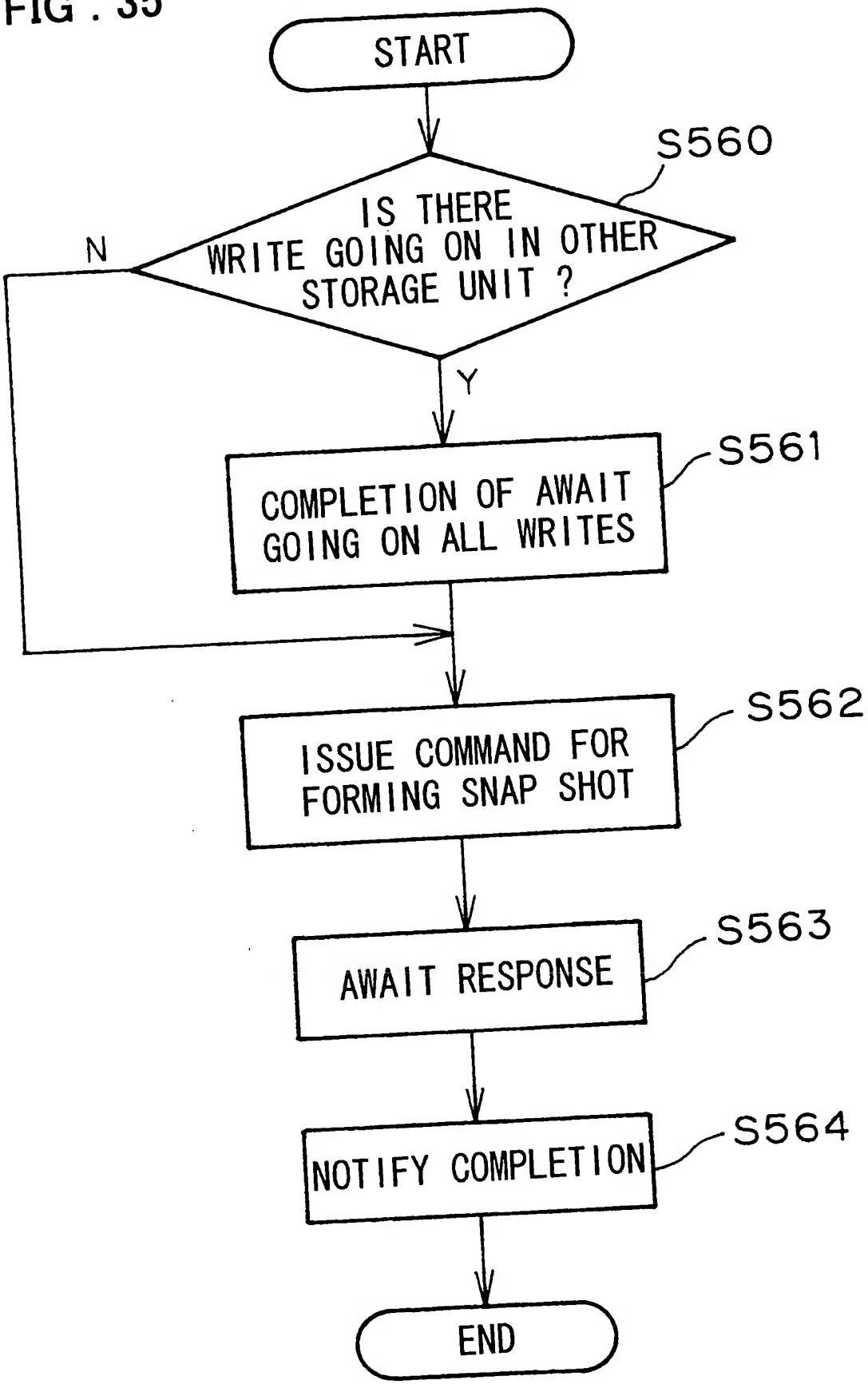

START
S560
IS THERE WRITE GOING ON IN OTHER STORAGE UNIT ?
N
Y
S561
COMPLETION OF AWAIT GOING ON ALL WRITES
S562
ISSUE COMMAND FOR FORMING SNAP SHOT
S563
AWAIT RESPONSE
S564
NOTIFY COMPLETION
END

FIG . 36

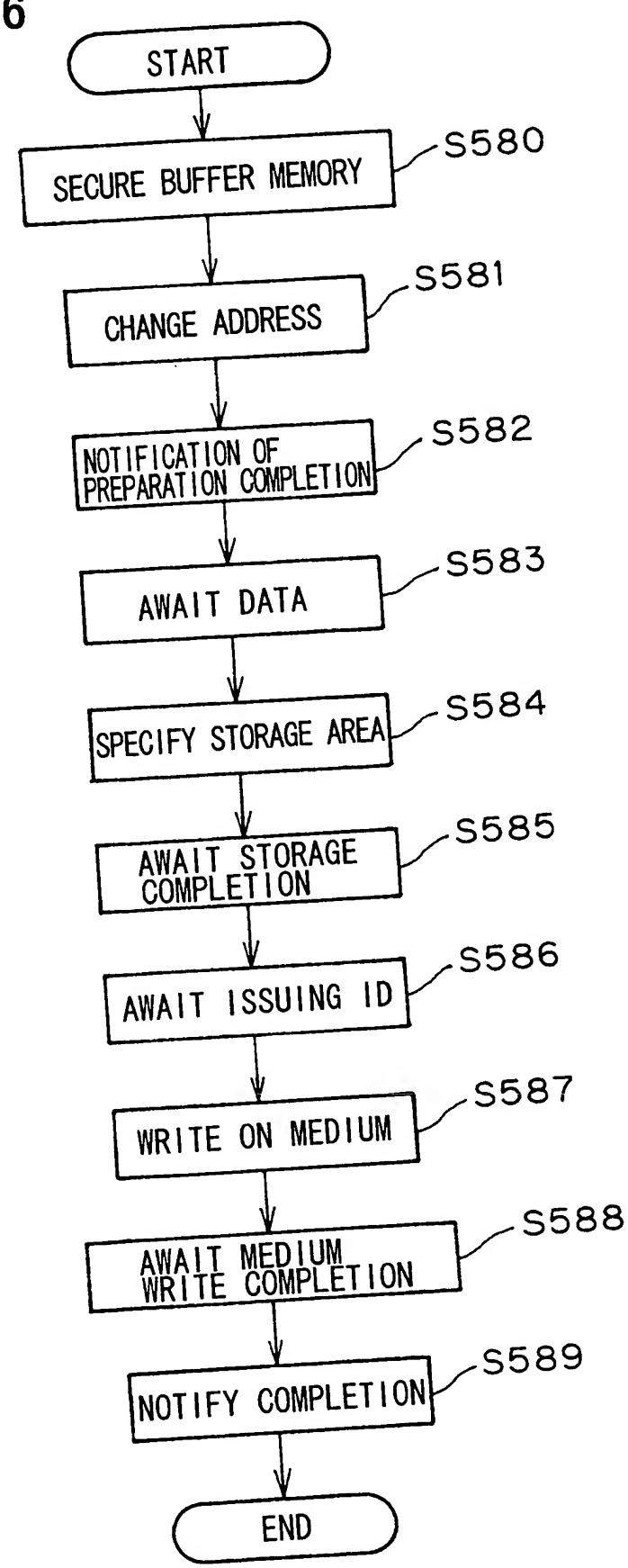

START
SECURE BUFFER MEMORY
S580
CHANGE ADDRESS
S581
NOTIFICATION OF PREPARATION COMPLETION
S582
AWAIT DATA
S583
SPECIFY STORAGE AREA
S584
AWAIT STORAGE COMPLETION
S585
AWAIT ISSUING ID
S586
WRITE ON MEDIUM
S587
AWAIT MEDIUM WRITE COMPLETION
S588
NOTIFY COMPLETION
S589
END

FIG . 37

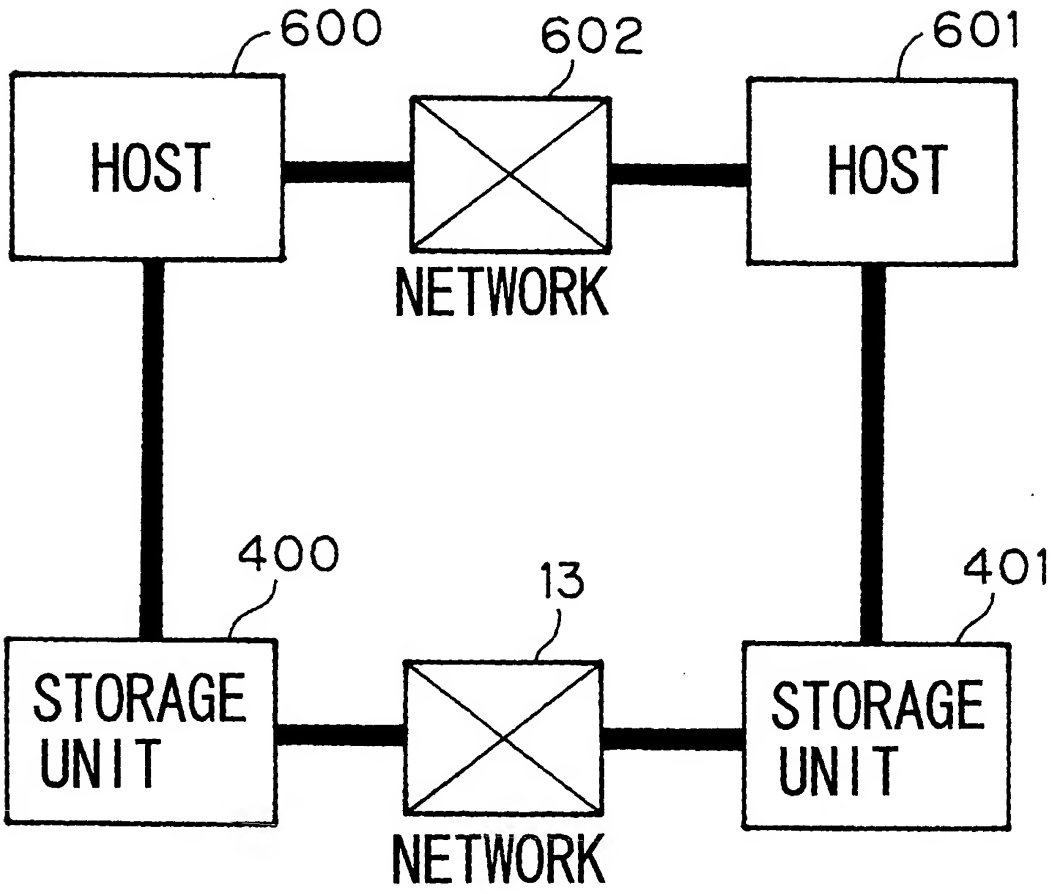

600
602
601
HOST
HOST
NETWORK
400
13
401
STORAGE UNIT
STORAGE UNIT
NETWORK

FIG . 38

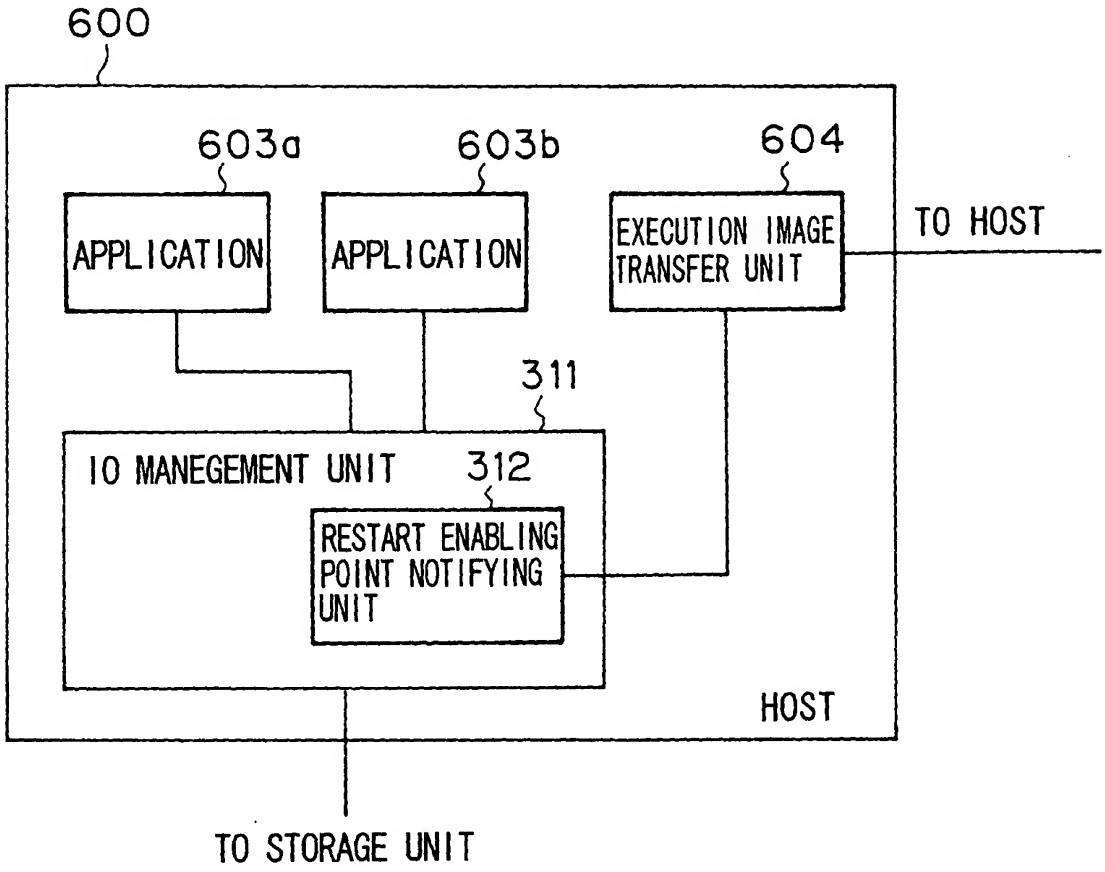

600
603a
603b
604
APPLICATION
APPLICATION
EXECUTION IMAGE TRANSFER UNIT
TO HOST
311
IO MANEGEMENT UNIT
312
RESTART ENABLING POINT NOTIFYING UNIT
HOST
TO STORAGE UNIT

FIG . 39

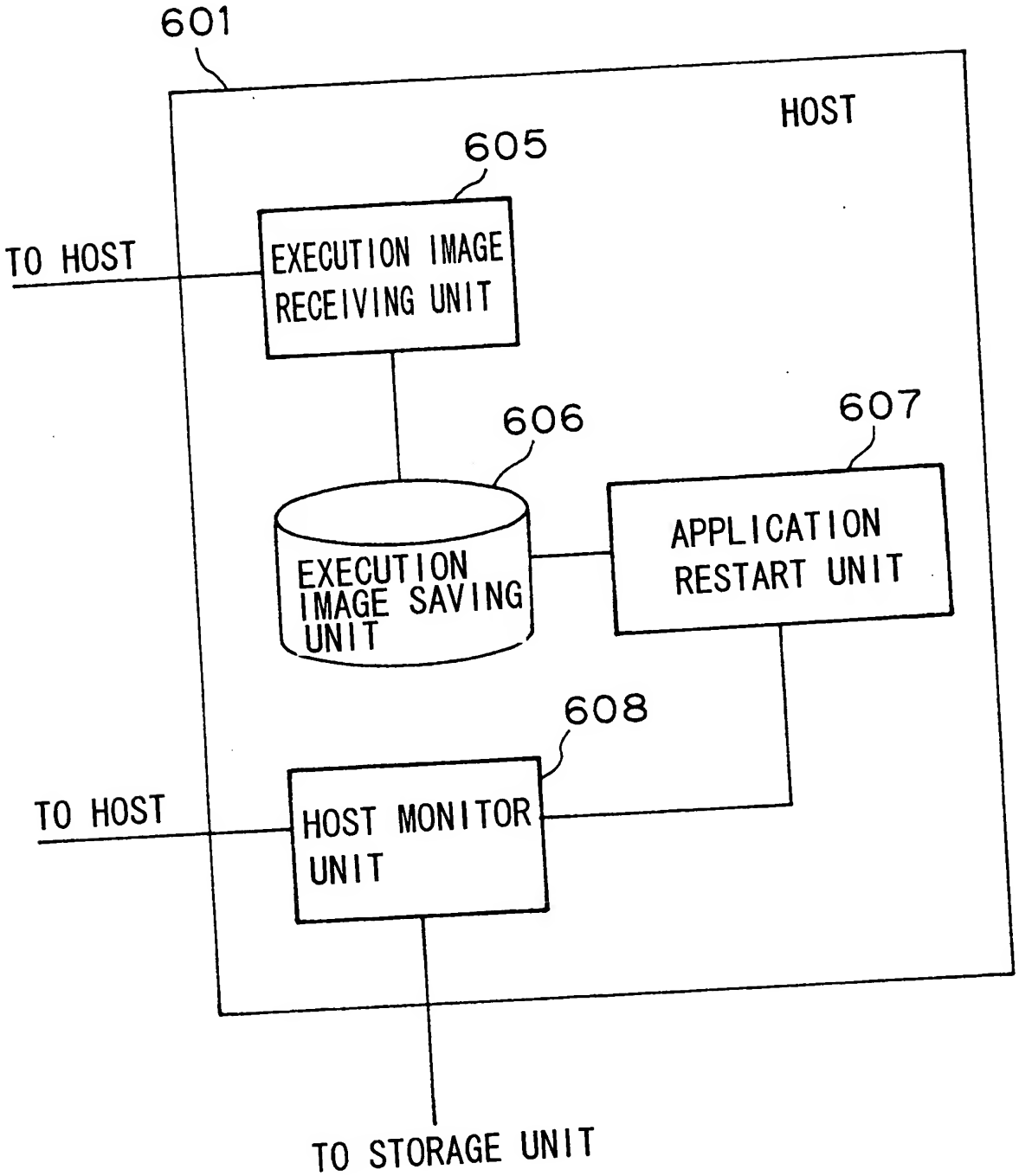

601
HOST
605
TO HOST
EXECUTION IMAGE RECEIVING UNIT
606
607
EXECUTION IMAGE SAVING UNIT
APPLICATION RESTART UNIT
608
TO HOST
HOST MONITOR UNIT
TO STORAGE UNIT

FIG . 40

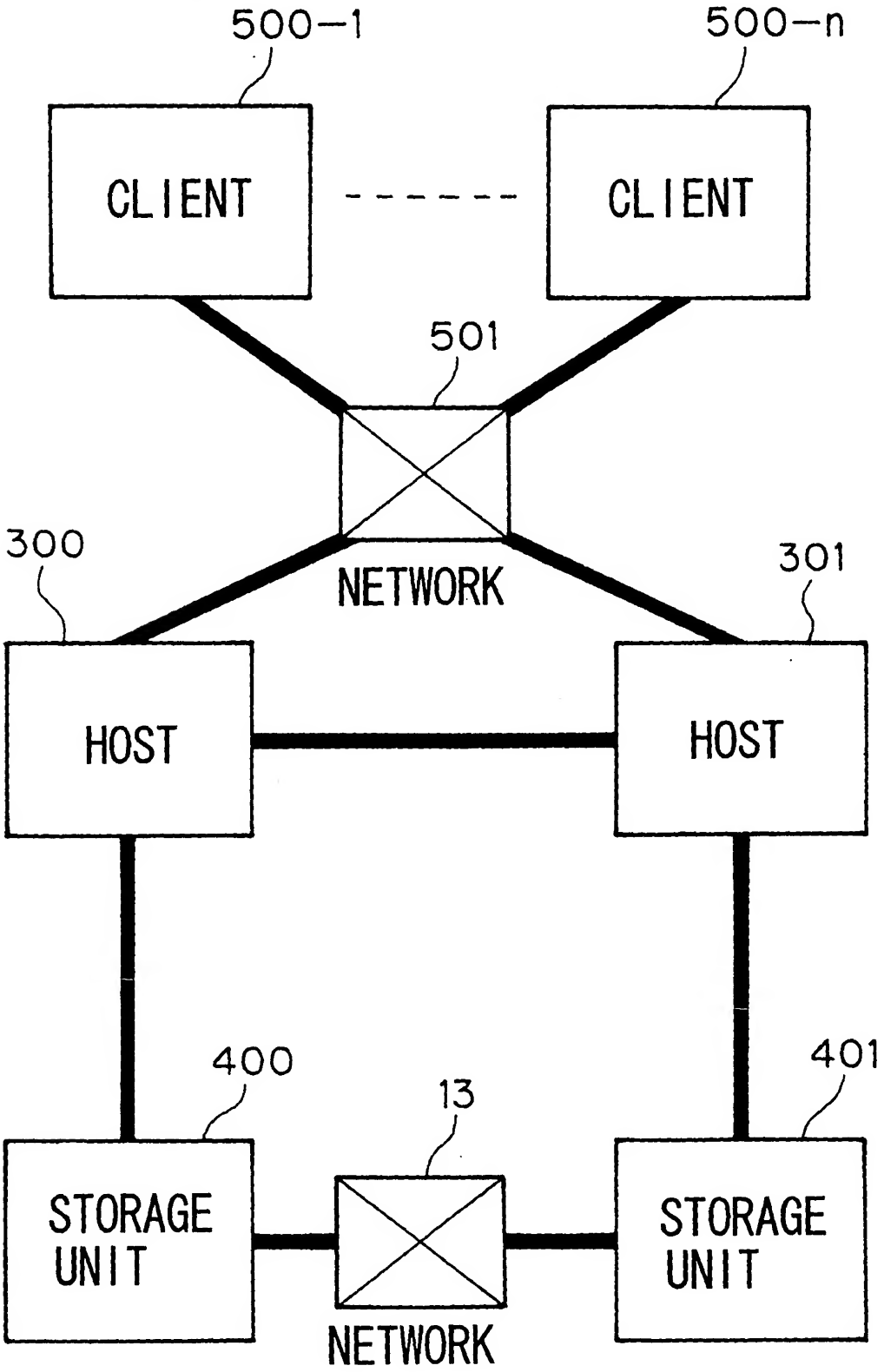
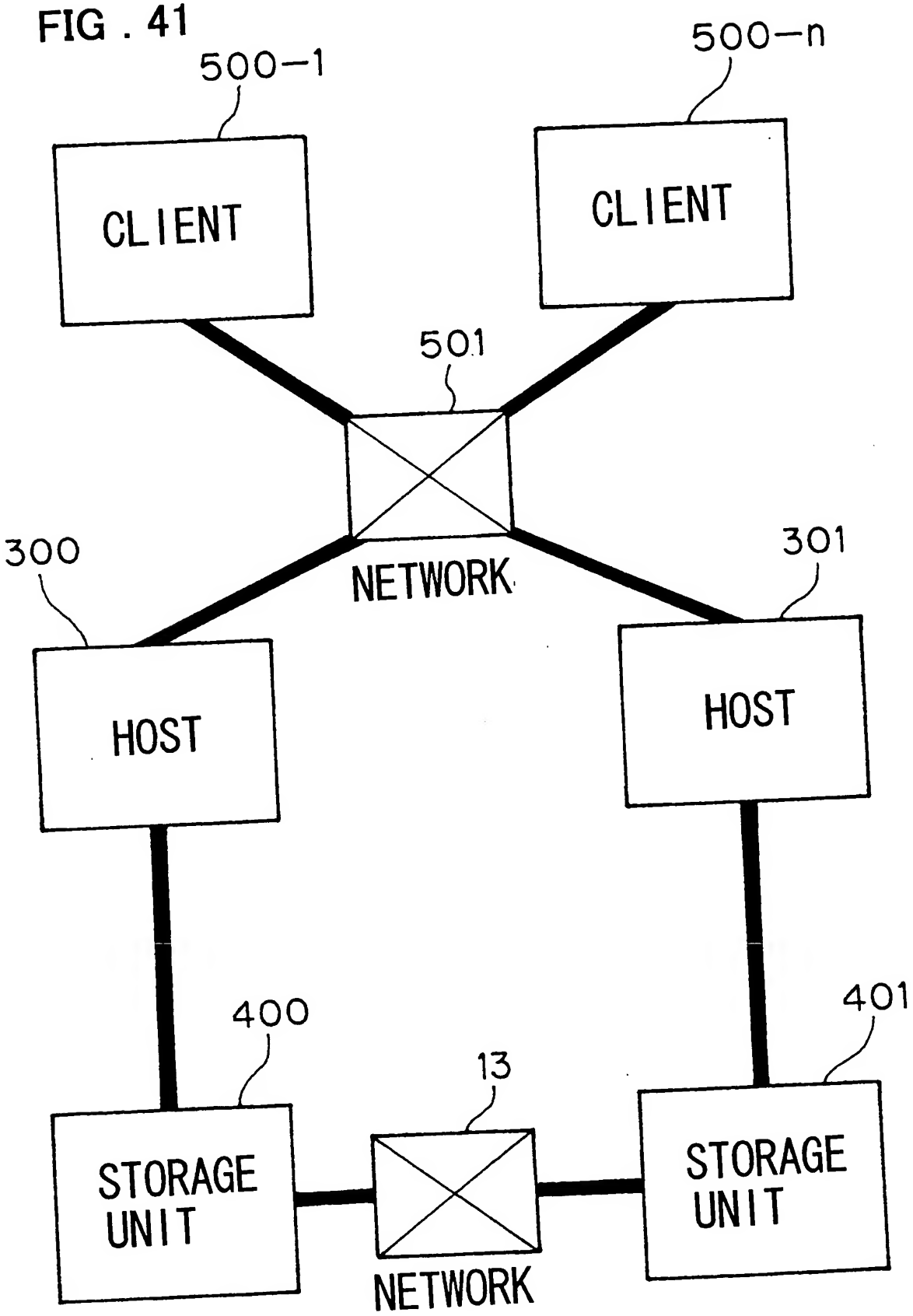

500−1
500−n
CLIENT
CLIENT
501
NETWORK
300
301
HOST
HOST
400
13
401
STORAGE UNIT
STORAGE UNIT
NETWORK

FIG . 41


500-1
500-n
CLIENT
CLIENT
501
NETWORK
300
301
HOST
HOST
400
401
13
STORAGE UNIT
STORAGE UNIT
NETWORK